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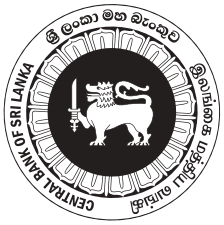

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Identifying Monetary Policy Rules for Sri Lanka

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Abstract

This paper characterises monetary policy of Sri Lanka using policy reaction functions over the period of 1996:Q1 to 2014:Q2, where the Central Bank of Sri Lanka (CBSL) broadly followed a monetary targeting framework in the conduct of monetary policy. The standard Taylor-type and McCallum-type policy rules, augmented with response to exchange rate variations are estimated for three different specifications: contemporaneous, backward looking and forward looking.

The forward looking Taylor rule and the backward-looking McCallum rule capture the monetary policy response in Sri Lanka. Results suggest that more than one-for-one reaction of the nominal interest rate in response to changes in inflation in the forward-looking Taylor specification is desirable as it leads to curtail inflation effectively, assuring determinacy. The coefficient of the output gap is, however, estimated to be larger than that of inflation. It is further evident that the CBSL responds to exchange rate variations only weakly while smoothing out interest rate strongly. A backward-looking McCallum rule where growth rate of monetary aggregate M1 (i.e. narrow money) reacts to growth rate of nominal GDP also seems to characterise monetary policy reaction in Sri Lanka satisfactorily. Strong policy smoothing and weak reaction to exchange rate are also evident in the McCallum rule.

***Key Words**: Monetary Policy, Taylor Rule, McCallum Rule, Monetary Policy Reaction Function, Sri Lanka*

***JEL Classification:** E31; E32; E52; E58; F41*

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1. Introduction

A monetary policy rule characterises the extent to which a central bank changes its policy instruments, in response to changes in inflation, output, or any other appropriate economic variables such as exchange rate. A rule based policy approach leads to a low and stable inflation and better economic stability. Such a well-defined policy rule improves transparency and predictability of policy reactions. Moreover, it enhances communication of the monetary policy stance to the market, with a higher certainty which is favourable for a healthy monetary transmission mechanism. This improves accountability while augmenting the long run credibility of the monetary authority (Clarida et al. (1998ba), Woodford (2001b), Woodford and Walsh (2005)). Commitment to follow a rule based monetary policy improves public confidence in the monetary authority, minimising the problem of time-inconsistency arising due to pure discretion.[2] Modern monetary policy rules, however, allow discretion of the central bank to a certain extent while enabling it to implement feedback reaction, curtailing persistence of various shocks to the economy (Taylor and Williams (2010)). There are two popular policy rules, the Taylor rule and the McCallum rule, that are widely used in capture monetary policy decision making behaviour.

The Taylor rule was originally introduced by Taylor (1993a), who successfully captures monetary policy decision making process by the Federal Reserve Bank of the USA during the period of 1987 to 1992. Owing to its simplicity, transparency and success reported in the last two decades, many modern central banks use different versions of the Taylor rule in conducting monetary policy. McCallum (1988), on the contrary, introduces a policy rule where the base money growth rate responds to changes in the nominal GDP growth rate. This rule is tested to be more suitable for some economies and Stark and Croushore (1998), for instance, argue that the McCallum rule leads to lower inflation than there has been over the last 30 years, in the US economy. Both rules, Taylor and McCallum, are simple and transparent in nature and aimed at delivering improved macroeconomic performance, smoothing out unexpected fluctuations of few key macroeconomic variables around their targeted paths. They both advocate that central banks should respond to dynamic conditions in an activist manner.[3] Interestingly, one can use these rules even without specifying a full model for the entire economy.

While there is extensive literature documenting and estimating monetary policy rules in developed economies, the estimation of such rules in emerging and developing countries is limited. This is because of under-developed financial markets and the unavailability of reliable data with sufficiently long-time spans. This study estimates alternative monetary policy rules, of the Taylor type and the McCallum type, for Sri Lanka from 1996:Q1 to 2014:Q2. Present

[2] Fundamentally a policy rule limits the discretion of a monetary authority.

[3] Activist policy refers to monetary and fiscal policies of a government which believes in active participation in the national economy to effect its economic agenda and objectives.

empirical study, thus allows one to check the appropriateness of an interest rate based policy rule against a monetary targeting policy rule in the context of Sri Lanka. This is important since Sri Lanka is currently in the process of entering into a flexible inflation targeting (FIT) framework, expecting to adopt it fully by 2020. As such, understanding the features of the previous regime's policy reaction function would provide useful insights in implementing the FIT framework effectively.[4]

The rest of the paper is structured as follows: Section 2 reviews literature and provides a brief overview of the monetary policy framework in Sri Lanka; Section 3 discusses the methodology; Section 4 describes the data and provides empirical results, and Section 5 concludes.

2. Literature Review

The dialogue on monetary policy rules has a history of over half a century. In 1959 Milton Friedman, for instance, advocated the Federal Reserve an annual increase of the money supply by four percent in order to avoid inflation. Orientation in the focus of the discussion changed when Barro and Gordon (1983) challenged the perception that policy reaction functions necessarily involved fixed values in the policy instrument variable of the central bank. Their argument was based on the inspirations of Kydland and Prescott (1977). This discussion tends to distinguish between the rules vs. discretion dichotomy from the issue of an activist vs. non-activist policy.[5]

Motivated by the influential papers of McCallum (1988) and Taylor (1993a), research activities in the policy rules intensified greatly in the 1990s, creating a huge information base useful for the conduct of monetary policy.[6] Monetary policy rules, soon became an active area of macroeconomic research, leading to the emergence of different forms and alternative variants of the rules. Clarida and Gertler (1997), for example introduced forward-looking versions of the simple backward-looking policy rule introduced by Taylor (1993a), that proved to be more appropriate in many empirical studies. One important feature of the forward-looking specification is that it allows the monetary authority to consider a number of different information sources (not limited to inflation and output), in forming expectations

[4] The CBSL was following a monetary policy framework based on monetary aggregate targeting until around 2015. Then it gradually moved towards enhanced monetary policy framework towards adopting a flexible inflation targeting framework in the medium term. The main monetary policy instruments currently used by the CBSL are: (a) policy interest rates and open market operations (OMO) and (b) the statutory reserve requirement (SRR) on commercial bank deposit liabilities

[5] For details, see for instance, McCallum (1999a)

[6] Taylor (1993b), Fair and Howrey (1996), Rotemberg and Woodford (1997) Levin (1996), Ball (1999), McCallum (1999b), Bernanke and Woodford (1997), Clarida and Gertler (1997) Orphanides (2001), Fuhrer and Madigan (1997), Svensson (2000) are among them.

of the future state of the economy. Further, Clarida et al. (1998b) argue that some form of inflation targeting is better than fixing exchange rates as a means of gaining a nominal anchor in monetary policy conduct.

Macroeconomic data series such as inflation and output gap used in estimating monetary policy rules are subject to various errors and frequent revisions. As Orphanides (2001) emphasises, one main practical hindrance in the implementation of monetary policy is the difficulty of obtaining appropriate measurements for the required variables. Neither the output gap nor the equilibrium real interest rate are observable, and hence possible errors associated with estimating these latent variables together with the uncertainties of the processes of determining them add up to total measurement errors (see for instance, Orphanides and Van Norden (2002) and Edge et al. (2010) for details). Based on the results of several studies on the implications of errors in measuring the output gap in monetary policy rules,[7] Taylor and Williams (2010) state that the size of the coefficient on the output gap changes due to errors in measuring the output gap.

Whether the role of the exchange rate is vital or not in the monetary policy rule is also an important question. This could be very relevant for a small open economy such, as Sri Lanka, which is vulnerable to various external shocks. Ball (1999) uses a small open economy to evaluate the importance of the exchange rate in the monetary policy rule and concludes that the inclusion of exchange rate in simple monetary policy rules improves the macroeconomic performance in the model. He incorporates both contemporaneous and first-lag values of exchange rate as explanatory variables in a simple monetary policy rule and finds that the standard deviation of the output can be reduced significantly by introducing exchange rate, holding inflation variability unchanged. In a detailed analysis of the role of the exchange rate in monetary policy rules, Taylor (2001), however, finds that monetary policy rules that reacts directly to the exchange rate, in addition to the fact that the output and inflation do not work better in stabilising inflation and real output and occasionally underperform than the rules that react to exchange rate only indirectly, in the context of the US economy.

Taylor (1993b) finds that a certain degree of interest rate inertia in the monetary policy rule can significantly improve performance of a forward-looking model such as the Federal Reserve Board's FRB/US large scale rational expectations model. Central banks tend to smooth changes in interest rates for the obvious reasons, such as fear of disrupting capital markets, possible losses of credibility due to large/abrupt policy rate reversals and the necessity of consensus building to support a particular policy change (Clarida et al. (1998a)).

Zero Lower Bound (ZLB) on interest rates is another important concern which is discussed in relation to monetary policy rules by many, including Orphanides et al. (1998) and Taylor

[7] This include, Orphanides et al. (1998), Gerlach and Smets (1999), Orphanides (2001), McCallum (2001), and Rudebusch (2001).

and Williams (2010). Though cash is an asset, it pays zero interest and therefore, short term interest rate will not go below zero for a long period. This limitation of the interest rate is a hindrance to proper conduct of monetary policy aiming at minimising inflation and output fluctuations.[8] Several concerns of monetary policy rules, arising from Zero Lower Bound are identified by Taylor and Williams (2010) including (1) possibility of existence of multiple steady states, (2) implications for the specification and parametrisation of the monetary policy rule, (3) tendency towards a higher target inflation rate than otherwise would be the case.

Taylor and Williams (2010) find that simple normative rules are robust and perform well in a variety of novel and rigorous models and policy evaluations. They further argue that such simple rules work better and lead to improved macroeconomic performance when decisions are based on such rules. There are some inherent informational difficulties, however, associated with implementation and interpretation of simple monetary policy rules. In a related study, Orphanides (2001) emphasises that policy rules estimated by using revised ex-post data could lead to outcomes that are much different from the actual historical reality. It could possibly suggest a different behaviour of the monetary authority than the one it faced with real time information, obscuring the truth.

In the recent years, a considerable number of studies have taken place on monetary policy rules and related areas in developing countries.[9] These studies mainly attempt to estimate alternative monetary policy rules for their respective countries. Many of these studies focus on Taylor type policy rules with quarterly data and found that forward-looking specifications work well (Perera and Jayawickrema (2014),[10] for instance) while others use McCallum type policy rules only (Kozmenko and Savchenko (2013), for instance), for the purpose. Some of them, however, use both types, as well as hybrid versions of the two rules (as reported in Esanov et al. (2005), Khakimov et al. (2010) and Patra and Kapur (2012)). These studies suggest that there is no any universal rule which suits all countries in all periods. Instead they found that different rules are preferred in different countries and even within a country, some rules work better than others under different policy regimes.

[8] For details, see for example Fuhrer and Madigan (1997), Eggertsson and Woodford (2003) and Chung et al. (2010)

[9] Esanov et al. (2005) for Russia, Khakimov et al. (2010) for Turkey, Aleem and Lahiani (2011) for Pakistan, Patra and Kapur (2012) for India, Wimanda et al. (2012), Boamah (2012) for Ghana, Kozmenko and Savchenko (2013) for Ukraine and Perera and Jayawickrema (2014) for Sri Lanka, are among them.

[10] Perera and Jayawickrema (2014) characterise the monetary policy decision making process for Sri Lanka using standard Taylor-type monetary policy rules. Further, they have estimated alternative monetary policy reaction functions for Sri Lanka over the period 1996Q1 to 2013Q2. However, their discussion was limited to Taylor type policy rules, thus refraining from any discussions on McCallum-type policy rules.

2.1 A brief discussion of Sri the Lankan Monetary Policy Framework

The Monetary Law Act of 1949 established the Central Bank of Sri Lanka (CBSL) to administer and regulate the monetary system of the country. It specifies the function of, confers powers, and imposes responsibilities upon the Monetary Board of the CBSL which is the monetary policy decision making authority in Sri Lanka. As such, the monetary policy targets are determined by the Monetary Board and the CBSL conducts monetary policy, broadly, by managing cost of money (i.e. interest rate) and availability of money (i.e. credit availability).

The CBSL has been following a monetary targeting framework in monetary management in Sri Lanka. Since the 1980s, the final target of price stability is accomplished by influencing the broad money supply that is closely connected with reserve money through a multiplier, in this framework. The CBSL employs a monetary programme, prepared by considering various macroeconomic elements, including the balance of payments developments, expected economic growth, desired levels of credit and inflation, exchange rate dynamics and anticipated fiscal balances, in assessing the required monetary growth. This enables determination of quarterly reserve money targets necessary to achieve the expected monetary growth.

Over the last two decades, the CBSL has gradually adopted a market oriented monetary management policy framework, instrumented with policy interest rates, replacing the non-market oriented policy instruments while minimising direct controls on interest rates and credit. Important milestones in this evolutionary process include introduction of the Re-purchase (Repo) facility in October 1993, Reverse Repurchase (Reverse Repo[11]) facility in November 1998 and comprehensive open market operations (OMO) in March 2003. The CBSL started to use two main monetary policy instruments: first, policy interest rates (interest rates on overnight repurchase and reverse repurchase agreements) with open market operations and second, the statutory reserve requirement (SRR) on commercial bank deposit liabilities.

The CBSL conducts its Open Market Operations within a corridor of interest rates formed by its policy rates (i.e. the repurchase rate and the reverse repurchase rate), in achieving the expected reserve money target. Regular reviews and revisions are made to the policy rates as required, to ensure that the reserve money is in its targeted path. When the CBSL made changes in the repurchase rate or the reverse repurchase rate, an instantaneous revision can be observed in the inter-bank call money market and then in other flexible short-term rates including Treasury bill rates and prime lending rates. This in turn, tends to influence a set of different interest rates at which commercial banks and other financial institutions

[11] Under present terminology, Repo and reverse Repo are known as the Standing Deposit Facility Rate (SDFR) and the Standing Lending Facility Rate (SLFR), respectively.

lend/borrow, with different time lags. Subsequently, it influences consumption/ investment decisions and thereby aggregate demand, affecting cost of production, wages and prices in the economy. As opposed to the OMO, the statutory reserve ratio (SRR)[12] has not been frequently used as a means of controlling money supply.

The CBSL observed over the period that the correlation between the monetary aggregates and the central bank policy rates was becoming weak, as noticed in several other countries in different time periods. Accordingly, in early 2017 CBSL announced its expectation to transit to flexible inflation targeting framework (FIT)[13] in 2020. The CBSL at present conducts monetary policy within an enhanced monetary policy framework which shares features of both monetary targeting and FIT. This framework enables the CBSL to stabilise inflation in mid-single digits over the medium term, while facilitating economic growth and flexibility in exchange rate management. As such, the CBSL uses several policy instruments to guide short term interest rates in conducting the monetary policy and employs average weighted call money rate (AWCMR) as the operating target.

Under the FIT regime, CBSL will announce the inflation target for a period and adjust interest rates accordingly. The strategy is expected to maintain price stability and thereby pave the way to progress as an upper middle-income economy over the medium term. The CBSL has formulated a 'Road Map' for the adoption of FIT, outlining the necessary reforms, the amendment of the Monetary Law Act, to accommodate such a monetary policy formulation regime, and innovations relevant to institutional features, operational features, monetary policy implementation, exchange rate policy and foreign exchange operations as well as capacity building, to facilitate the smooth transition to the new regime. In addition, the Central Bank continues to strengthen monetary policy communication with relevant stakeholders, in line with the growing importance of effective communication in monetary policy transmission. Further, a notable progress has been made in fulfilling the requirements pertaining alignment of both fiscal and monetary policy towards achieving inflation targets in a coherent manner which are essential for successful implementation of FIT (CBSL 2017, 2018).

[12] This refers to the fraction of the obligatory deposit liabilities that commercial banks are mandatory to keep as a cash deposit with the CBSL.

[13] According to Bernanke and Mishkin (1997), inflation targeting approach is characterised, as the name suggests, by the announcement of official target ranges for the inflation rate at one or more horizons, and by explicit acknowledgment that low and stable inflation is the overriding goal of monetary policy. Other important features of inflation targeting include increased communication with the public about the plans and objectives of the monetary policymakers, and, in many cases, increased accountability of the central bank for attaining those objectives.

3. Methodology (Different Types of Monetary Rules)

This study focuses on Taylor rule type specifications since the CBSL used policy interest rate as the main conducting instrument in monetary policy during the period under consideration. The CBSL used monetary targeting policy framework and accordingly, the study also analyses suitability of the McCallum type types of policy rules for the country. These two types of rules are estimated and compared with lagged, contemporaneous and forward-looking specifications as it is worthwhile to test all of them, without taking any priori presumptions, in selecting the most suitable rule in explaining the behavior of monetary policy formulation.

3.1 Taylor rule specifications

Taylor (1993a) finds that the Federal Reserve usually calls for changes in the federal funds rate in response to changes in either the price level or changes in real income. Thus, the Taylor rule specifies the short-term interest rate (i_t) as follows:

$$i_t = r^* + \pi_t + \emptyset_\pi(\pi_t - \pi^*) + \emptyset_y ygap_t \qquad (1)$$

where, r^* is the equilibrium real interest rate, π_t is the inflation rate in period t, π^* denotes the inflation target and $ygap_t$ is the output gap which is the deviation of real GDP from its potential level. The magnitude of the coefficients $\emptyset_\pi$ and $\emptyset_y$ denotes the aggressiveness of the policy reaction of the central bank, for which he assigned values 0.5 each. The equation (1) above says in essence that in the steady sate where inflation equals its target and the output gap equals zero, the real interest rate (i.e. the nominal interest rate net of expected inflation) equals the equilibrium real interest rate. The rule implies that the monetary authority sets the nominal interest rate above (below) the steady state level interest rate, when inflation is above (below) the target and/or output is above (below) its potential level, and vice-versa.

The original Taylor rule, first presented in Taylor (1993a), set r^* equal to 2 and the π^*equal to 2 as well. Accordingly, the equation (1) can be arranged as, $i_t = \pi_t + 0.5ygap_t + 0.5(\pi_t - 2) + 2$, or equivalently, as follows:

$$i_t = 1 + 1.5\pi_t + 0.5ygap_t \qquad (2)$$

This says that the short-term interest rate equals one and a half times the inflation rate plus one half times the output gap plus one.[14] Simulation studies reveal that this equation works well with US data.

[14] Taylor (1993) uses quarterly data and used a moving average of inflation over four quarters.

The Taylor rule suggests two important results in stabilising inflation and output: (1) the more than one-for-one response to inflation which is referred to as the Taylor principle[15] by Woodford 2001b: When inflation starts to increase, the Taylor rule advocates for the monetary authority to raise the interest rate more rapidly to curtail inflationary pressure; and (2) the leaning against the wind character: which means increasing the interest rate when output exceeds its potential level and vice-versa. Hence, the monetary authority's reaction enables it to bring back both the inflation and output, whenever they deviate from their corresponding targets.

Research examining the monetary policy reaction functions in emerging markets suggests that open economy rules in which policy instruments respond to deviation of exchange rate (Δet), in addition to the output gap and inflation deviation, perform better than the closed economy version of the model. Being a small open economy with increased foreign exchange transactions and sovereign bond issues, foreign exchange management could also have a bearing on monetary policy in Sri Lanka. Accordingly, I follow Patra and Kapur (2012), Llosa and Tuesta (2008) and Araujo (2014), where the original Taylor rule is augmented with exchange rate deviation and a certain degree of interest rate inertia, as follows:

- Contemporaneous version

$$i_t = \emptyset_0 + \emptyset_\pi(\pi_t - \pi^*) + \emptyset_y ygap_t + \emptyset_e \Delta e_t + \emptyset_i i_{t-1} + \varepsilon_t \quad (3)$$

- Backward-looking version

$$i_t = \emptyset_0 + \emptyset_\pi(\pi_{t-1} - \pi^*) + \emptyset_y ygap_{t-1} + \emptyset_e \Delta e_{t-1} + \emptyset_i i_{t-1} + \varepsilon_t \quad (4)$$

- Forward-looking version

$$i_t = \emptyset_0 + \emptyset_\pi(E_t[\pi_{t+1}] - \pi^*) + \emptyset_y E_t[ygap_{t+1}] + \emptyset_e E_t[\Delta e_{t+1}] + \emptyset_i i_{t-1} + \varepsilon_t \quad (5)$$

where, E_t is the expectations operator, $\emptyset$ terms are the corresponding coefficients and ε_t is an error term capturing any deviations from the Taylor rule. Other symbols denote the same quantities, as above. For each of the above three specifications, two cases, one including and the other excluding exchange rate, are tested. Further, two alternative candidates for the monetary policy instrument (i.e. short run interest rate), which are the Average weighted call money rate and the 91-day Treasury bill rate are used in each case.

[15] This condition is required in most of the macroeconomic models to ensure existence of a determinate solution, as explained in detail in Woodford, 2003.

3.2 McCallum Rule Specifications

McCallum (1988, 2000) explains the monetary policy rule that relates the policy instrument and growth of the reserve money, to the target variable which is the growth rate of nominal GDP, as follows:

$$\Delta m_t = \Delta x^* - \Delta v_t^a + \lambda(\Delta x^* - \Delta x_{t-1}) \qquad (6)$$

where, Δm_t, Δv_t^a, Δx_t and Δx^*denote the growth rates of the base money, base velocity, nominal GDP and nominal GDP target respectively[16] and λ is the coefficient of deviation of GDP growth rate from its target.[17]

The McCallum Rule consists of three main parts: (1) the target for the current growth of nominal GDP, (2) a moving average adjustment for the variations in velocity and (3) a difference between the nominal GDP growth with its target value. In essence, the rule targets nominal GDP growth by setting the growth rate of money supply, allowing the economy to expand at its normal pace, stabilising inflation indirectly.

The velocity term captures the long run demand changes for the base money stock, attributable to the technological advancements or regulatory variations taking place. Not all changes in money base are attributable to velocity changes; velocity change is intended to capture variations in the long run trend only (McCallum and Nelsson, 1989). The cyclical changes, on the other hand, are reflected by the final term which recommends a downward adjustment to the base money growth (i.e. tightening the monetary policy stance) when Δx_{t-1} is above Δx^* and vice-versa.

The policy instrument used in the McCallum rule is the high-powered money (reserve money). It is, however, important to make necessary adjustments to the reserve money aggregate so as to account for the changes in the Statutory Reserve Requirement (SRR) during the period of analysis (McCallum 1990, 2000).

The main parameter in the McCallum rule is the coefficient on the GDP deviation term, λ. This explains how much the money base should be changed in response to a nominal GDP variation from its target, $(\Delta x^* - \Delta x_{t-1})$. A large value for the response coefficient could lead of the monetary policy in influencing the economy.[18]

It is also important to note that in the McCallum rule, nominal GDP variation from its target is measured as the target value minus the realised value, in contrast to the Taylor Rule which

[16] For the US, McCallum assumed it to be 5 percent
[17] McCallum (1993) set λ=0.5, for the US.
[18] Among others, McCallum (2000), Croushore and Stark (1996), Hall (1990) suggest λ=0.5, for the U.S. economy.

defines the deviations as the realised value minus target. Accordingly, when the GDP growth is less than the target for example, the rule together with the positive coefficient λ advocates an expansionary monetary policy stance with an increase in reserve money growth rate.

The McCalllum rule uses average growth of base velocity over the previous 16 quarters in characterising the rule. This is a major hindrance in estimating the rule for a country with a short data span, since it requires discarding a large number of observations so as to average the velocity of money over the four-year period. In developing countries, reliable quarterly velocity data are either unavailable or available only for a limited short period. Thus, authors including Esanov et al. (2005) and Patra and Kapur (2012) adopt variants of the McCallum rule, avoiding the velocity term. Omitting the velocity term does not make much difference, if the growth rate of base velocity is nearly constant over the period.[19] Annual velocity figures for Sri Lanka reveal that it has been stable around an average of 3.38 over the last 30 years with an annual average growth rate of only -0.49 percent[20] and hence the contribution of the velocity growth term is negligible. Considering the above and the fact that Sri Lanka do not have quarterly velocity data, I use a McCallum rule specification, which excludes the velocity term.

Similar to the extended Taylor rule above, Esanov et al. (2005) and Patra and Kapur (2012) use additional terms for policy smoothing and exchange rate variation which could be relevant in the Sri Lankan context, too. Accordingly, I use the following rules:

- Backward-looking model;

$$\Delta m_t = c_1 + c_2(\Delta x^* - \Delta x_{t-1}) + c_3 \Delta e_{t-1} + c_4 \Delta m_{t-1} \qquad (7)$$

- Forward-looking model[21]

$$\Delta m_t = c_1 + c_2(\Delta x^* - \Delta E_t x_{t+1}) + c_3 \Delta E_t e_{t+1} + c_4 \Delta m_{t-1} \qquad (8)$$

In each of the above two cases, two specifications (one including and the other excluding exchange rate) are tested. Further, two alternative candidates for the monetary policy instrument, which are the Reserve money (adjusted for the Statutory Reserve Requirement (SRR)) and the Narrow money are used.

[19] This leads to an approximately zero-base velocity growth, thus, justifying the omission of the velocity term.
[20] Data source: Special Appendix - Annual Report of the CBSL (2014)
[21] The original McCallum rule is presented in the backward-looking form. Following Patra and Kapur (2012), I use both backward-looking and forward-looking specifications of the McCallum rule.

3.3 Monetary policy rule and determinacy

The question of whether a policy rule proposed is associated with a unique determinate solution is an important consideration in deciding on the most suitable alternative policy rule among several alternatives (Bernanke and Woodford (1997), Clarida et al. (1998a), Bullard and Mitra (2002, 2007)). Some types of policy rules are associated with large sets of rational expectations equilibria out of which some may cause fluctuations in key variables in the model such as inflation or real output, entirely attributing to self-fulfilling expectations. Accordingly, such equilibria should be prevented from selecting paths with economic stability. Monetary authorities have shown a tendency towards smoothing out the nominal interest rate, in response to fluctuations in the economy. When it decides to change the nominal rate, the central banks, in fact practically implement it as a sequence of small deviations in the desired single direction which will sum up to the expected total change. Bullard and Mitra (2007) consider two variants of the monetary policy reaction functions suggested by Taylor (1993a, 1999a,b) and conclude that monetary policy inertia enhances the prospects for equilibrium determinacy and learnability in a standard, small, forward-looking model. Accordingly, the analytical conditions which ensure determinacy in the two cases, including interest rate smoothing and excluding it, are discussed below.

3.3.1 Determinacy in the absence of interest rate smoothing

With a greater emphasis, Taylor (1993b, 1999a) argues that it is important to respond to inflation above the target rate, by raising the nominal interest rate operating target by more than the amount by which inflation exceeds the target. Taylor (1999a) attributes the Federal Reserve's failure to adhere to this principle, to the large macroeconomic instability in the U.S. in the *pre-Volcker* period.

Woodford (2003) considers a Taylor rule of the form:

$$i_t = \phi\left(\frac{\Pi_t}{\Pi_t^*}; \nu_t\right)$$

where, $\Pi_t = \frac{P_t}{P_{t-1}}$ is the gross inflation, Π_t^* is the inflation target, possibly time varying, and ν_t represents exogenous factors which shifts this relation and $\phi(.;\nu)$ is an increasing function for each value of ν. A log-linear approximation to the above rule is given by,

$$\hat{\imath}_t = \phi_\pi(\pi_t - \pi^*) + \nu_t \qquad (9)$$

where $\pi^* = log\Pi_t^*$ and $\phi_\pi > 0$ is the elasticity of ϕ with respect to its first argument. This can be rearranged as,

$$\hat{\imath}_t = \bar{\imath}_t + \phi_\pi \pi_t \qquad (10)$$

where $\bar{\imath}_t = \nu_t - \phi_\pi \pi_t^*$ measures the total exogenous shift in the monetary authority's reaction function. For a simple interest rate feedback rule of the above form, the rational-expectations equilibrium paths of inflation and nominal interest rate are determinate when the inflation coefficient, $\phi_\pi > 1$ and it is indeterminate, if instead, $0 \leq \phi_\pi < 1$.

3.3.2 Determinacy in the presence of interest smoothing

Policy reaction functions of the central banks typically include partial-adjustment dynamics of one or more than one lagged values of the interest rate. Specifically, it incorporates the idea that the current setting of the nominal interest rate is influenced positively by the lagged values of itself, besides the variables representing current economic conditions. Clarida et al. (1998b) among others, stress the importance of incorporating interest rate smoothing into the policy rule. Woodford (2003), for example considers a simple feedback rule with interest rate smoothing, as follows, to illustrate the determinacy conditions in such a case:

$$\hat{\imath}_t = \bar{\imath}_t + \rho(\hat{\imath}_{t-1} - \bar{\imath}_t) + \phi_\pi \pi_t \qquad (11)$$

The symbols carry their usual meanings as given above. Now, the coefficient $\rho \geq 0$ measures the degree of intrinsic inertia in the monetary authorities operating target.

When $\rho \leq 1$, the above rule can be solved backward, eliminating the dependence of lagged interest rate. In this new rearranged representation, the inflation response coefficient corresponds to $\phi_\pi / (1 - \rho)$. Thus, in line with the Taylor principle, Woodford (2003) argues that equilibrium is determinate if and only if,

$$\frac{\phi_\pi}{(1-\rho)} > 1 \qquad (12)$$

Accordingly, he interprets this condition as the case where eventual increase in the nominal interest rate as a result of the sustained increase in the inflation rate, is more than one- for-one. Well-behaved rational expectations equilibria can, however, exist even when $\rho \geq 1$. From the above inequality, it implies that for $\rho < 1$, the equilibrium inflation rate is determinate if and only if $\phi_\pi > 0$ and $\phi_\pi + \rho > 1$

This condition is valid more generally when $\rho \geq 1$, any positive value for ϕ_π is sufficient for determinacy and in fact, when $\rho > 1$, the equilibrium is determinate for the case where ϕ_π is slightly negative. It is however required that ϕ_π be not equal to zero to ensure determinacy.

The inflation response coefficient $\phi_\pi/\ (1-\rho)$ above is referred to as the long-run inflation response coefficient, by many authors including Nelson (2001) and Woodford (2003).

3.3.3 Determinacy in the presence of interest rate smoothing, while responding to both inflation and output

Gali (2009) analyses the determinacy condition for a Taylor type monetary policy reaction function of the following form, which responds to both inflation and output,[22]

$$i_t = \rho + \phi_\pi \pi_t + \phi_y ygap_t + u_t \qquad (13)$$

where, u_t is an exogenous component with zero mean, coefficients $\phi_\pi, \phi_y > 0$ are selected by the monetary authority, the intercept ρ, makes the rule consistent with a zero-inflation steady state.[23] Considering a system of equations consists of the above policy rule, together with a New Keynesian Phillips curve and a dynamic IS curve, Gali (2009) specifies the necessary and sufficient condition for uniqueness as follows: [24]

$$\kappa(\phi_\pi - 1) + (1-\beta)\phi_y > 0 \qquad (14)$$

where β is the discount factor,[25] κ is a parameter.[26] Thus, the central bank should respond to any deviations of inflation and output gap from their respective targets, by changing the policy interest rates with sufficient strength to assure a unique solution for the equilibrium.

4. Empirical Analysis

4.1 Data Description

I use quarterly data from 1996:Q1 to 2014:Q2 for this study. The selection of this particular period is due to the availability of quarterly data for many key macroeconomic variables in Sri Lanka, as well as the conduct of the *monetary aggregates targeted monetary policy framework* in the county, during the said period. The growth rates are calculated on a quarter-to-quarter basis and each of the data series used for the study and their sources are shown in the Table 1 given below.

[22] For details, see chapters 3 and 4 of Gali (2009).
[23] Note that the inflation target in this case is also zero.
[24] See Bullard and Mitra (2002) for a proof.
[25] Note that $\rho = -log\beta$
[26] Gali (2009) defines κ such that $\kappa = \lambda\left(\sigma + \frac{\phi+\alpha}{1-\alpha}\right)$ such that $\lambda = \left(\frac{(1-\theta)(1-\beta\theta)}{\theta}\right)\left(\frac{1-\alpha}{1-\alpha+\alpha\varepsilon}\right)$ where θ is the Calvo price stickiness parameter, α is the share of total income that goes to capital, ε is the elasticity of substitution among different varieties of goods, ϕ is the inter temporal elasticity of labour and σ is the inter temporal elasticity of substitution parameter.

Table 1: Data series and derived variables used in estimating rules

Variable [a]	Description [b]	Source [c]
AWCMR(i_t)	Average weighted call money rate (quarterly average)	CBSL
TBR(i_t)	Treasury bill rate (91 day)	CBSL
EXRVAR(Δe_t)	Variation in the quarterly average exchange rate	CBSL
INFGAP($\pi_t - \pi*$)	Deviation of inflation from the implied target [d]	DCS, AE
Y(y_t)	Nominal GDP	CBSL, DCS
Y GAP($y_t - \tilde{y}_t$)	Output gap; deviation of output from the its long term rend [e]	CBSL, DCS, AE
NDGPg(Δx_t)	Nominal GDP growth (quarter-on-quarter growth)	CBSL, DCS
ARMg(Δm_t)	Growth rate of Reserve Money [f]	CBSL
M_{1g}(Δm_t)	Growth rate of Narrow Money, M_1	CBSL
M_{2g}(Δm_t)	Growth rate of Narrow Money, M_2	CBSL

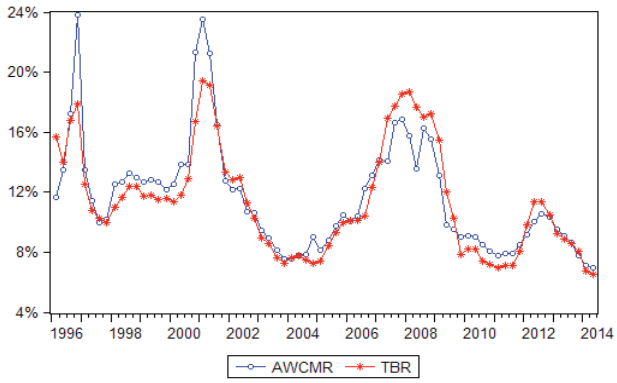
[a] In the models, either AWCMR or TBR is used as the policy instrument (not both).
[b] All these quantities are expressed as percentages.
[c] Abbreviations used are as follows; CBSL: Central Bank of Sri Lanka, MoFP: Ministry of Finance and Planning, AE: Author's Estimates, DCS: Department of Census and Statistics of Sri Lanka.
[d] Inflation is computed by using the Colombo Consumer's Price Index.
[e] Approximated by the HP trend.
[f] This is after making adjustments to the Statutory Reserve Requirement.

Preliminary data testing is useful in identifying possible data issues.[27] I plot all the data series first to check for any possible outliers, trends, discontinuities, changes in variability etc. Time plots of the key variables used in the study with a brief discussion are given in the following paragraphs.

Several alternative variables are used as the monetary policy instruments in related literature. In the Taylor rule specifications, short term interest rate, as reflected by 91-day Treasury bill rate, call money market rate and Repo, and reverse Repo rates are widely used in many studies while some alternatives such as effective policy rate[28] are also employed in other studies. The monetary policy stance of the CBSL is reflected by the short-term interest rates since the introduction of Open Market Operations. In this study, thus, the weighted average call money market rate (AWCMR) and 91-day Treasury bill rate (TBR) are used as the two alternative candidates for the monetary policy instrument in the Taylor rule specification. The Figure 1 given below shows that the AWCMR and TBR, move hand in hand displaying a close relationship with a strong correlation coefficient of 0.91.

[27] see for instance, Boschen and Mills (1992) and Hafer and Kutan (1997)
[28] For instance, Patra and Kapur (2012), Perera and Jayawickrema (2013) use a so called effective policy rate, which is the interest rate through which the central bank engaged in its liquidity operations with market participants, depending on prevailing liquidity conditions (in most of the time it is as same as either Repo or Reverse repo rate. The current study does not employ it since the data series is non-stationary for the period considered.

Figure 1: Short Term Nominal Interest Rates



Source: CBSL

The output gap[29] is an important variable in the modern macroeconomic models. Determination of the output gap is, however, challenging since the potential output is not directly observable. Among others, Giorno et al. (1995), De Brouwer et al. (1998), Orphanides and Van Norden (2002) and Gerlach and Yiu (2004) suggest alternative methods of determining output gap, explaining some of the pitfalls and complexities of the different techniques. Out of these methods, approximating the potential output by the Hodrick-Prescott filtered trend[30] (HP trend), is widely used, as it is easy to compute and communicate. Thus, the present study employs the same, as an approximation to the potential output.[31]

Exchange rate can be introduced to the monetary policy rule in different ways.[32] Ball (1999), for instance proposes two possibilities: either to include through an index made out of a weighted average of inflation and exchange to use as the policy instrument replacing the nominal rate, or to use the exchange rate in the righthand side of the equation. Following Patra and Kapur (2012), this study uses annualised quarter-on-quarter variation in the quarterly average exchange rate in the policy rule.

[29] The output gap is the percentage deviation of output (y) from its potential value (y∗), thus defined as: $[(y - y*) / y*]$.

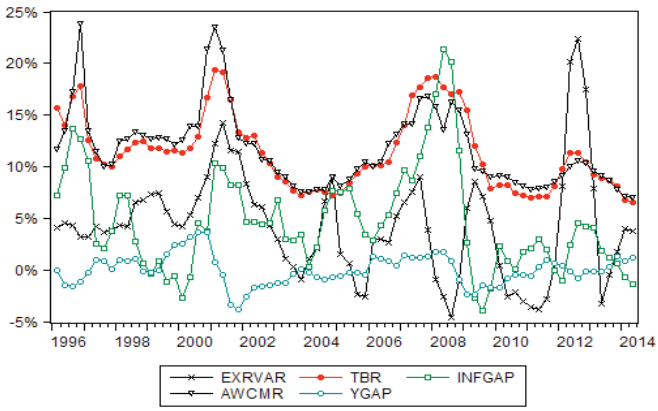
[30] The HP filter separates a time series into growth and cyclical components, thus, the decomposed series does not contain any seasonality. HP filter minimise the variance of the cyclical component, subject to a penalty for variations in the second difference of the growth term. Potential output estimation using the HP filter depends on the choice of the smoothing parameter, λ, and Hodrick and Prescott (1997), advocate λ= 1600 with quarterly data which is pretty standard now.

[31] For other de-trending techniques, see for instance: Lucas (1972), Beveridge and Nelson (1981), Blanchard and Quah (1988), Baxter and King (1999), and Kuttner (1994).

[32] Note that the exchange rate is expressed as the number of domestic currency (Sri Lankan Rupees) per one US Dollar (i.e. SLR/USD).

Among the different inflation indices including the Wholesale Price Index (WPI), Colombo Consumers Price Index (CCPI) and GDP deflator, the present study uses CCPI as it is the commonly used measure. Sri Lanka has not yet implemented an inflation targeting monetary policy framework, formally. The CBSL, however, signaled its ambition to maintain inflation at the midpoint of the single digit range, in the medium term. Accordingly, this study uses 4 to 6 percent as the inflation target for Sri Lanka.[33] Accordingly, the year on year change in CCPI is employed in determining the inflation and then, the deviation of inflation from its implied target value is computed as per the rule specification. Figure 2 given below depicts dynamics of the variable used in the estimation of Taylor Rule, over the sample period.

Figure 2: Time Plot of Variables Used for the Taylor Rule Estimation



Source: CBSL, Department of Census and Statistics (DCS) and author's calculations

Exchange rate variation (EXRVAR) appears to be having a moderate association with short run nominal interest rates until 2004, but it disappears thereafter.[34] Fully floating exchange rate management implemented by the CBSL in 2001, may explain this behaviour to some extent. Inflation gap (INFGAP) reflects a moderately strong association with short run nominal interest rates probably with a lag. Single digit lower inflation recorder since mid-2009 is notable and it is partly attributable to the CBSL's intense focus on curtailing inflation.

[33] This approach is followed in other similar studies for countries where a formal inflation target is unavailable. (See for instance, Patra and Kapur (2012)). Accordingly, for simplicity, the mid value of the range which is 5 per cent is used as the point target of inflation in this study. Alternatively, relaxing this simple assumption, one can use inflation averages over certain periods as implicit inflation targets.

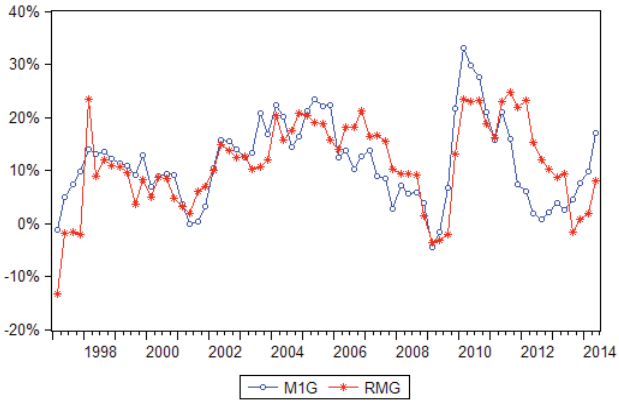
[34] Correlation coefficient of EXRVAR with AWCMR is only 0.31 for the full period considered.

GDP gap measure (YGAP) displays a moderate counter cyclical relationship, with a lag of apparently 2-3 quarters, as the YGAP curve approximately resembles the mirror image of the short-term interest curves. This suggests the forward-looking policy reaction of the CBSL, in stabilising the output gap.

The average inflation gap for the full sample period is 4.7 and this is highly influenced by the low inflation observed after 2008. The two alternative measures of the short-term interest rate, weighted average call money rate and T-bill rate recorded a mean value of 11.6 percent and 11.7 percent respectively. The average depreciation of the exchange rate, as reflected from EXRVAR is computed to be 4.3 percent and the variability of the series seems to be slightly lower in the period prior to fully floating. The mean value of the output gap is zero, as expected, since it is calculated with respect to the long-term trend approximated by the HP trend.

The two alternative policy instruments for the McCallum Rule specifications, growth rates of reserve money and narrow money (i.e. monetary base M1), are plotted in Figure 3. As expected, it reveals that the two series are highly associated with each other, as evident from the moderately strong correlation coefficient of 0.66, between them.

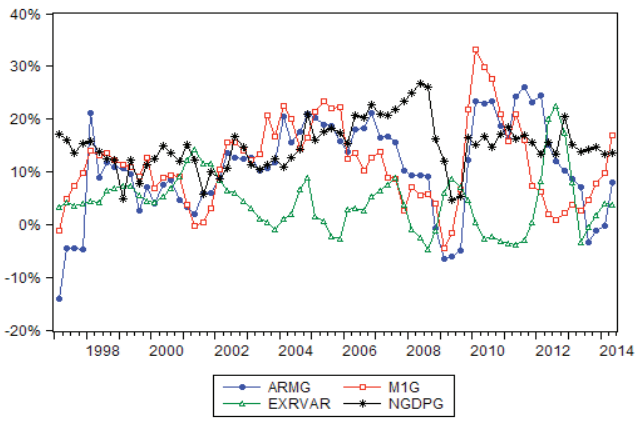
Figure 3: Growth Rates of Reserve Money and Narrow Money (Monetary Aggregate M1)



Source: CBSL and author's calculations

Figure 4 reveals dynamics of all four variables used in the McCallum rule estimation. It is evident that the nominal GDP growth rate (NGDPG) weakly follows the growth rate of the monetary bases, with a lag, accordingly, this behaviour seems to support the McCallum rule in Sri Lankan data.

Figure 4: Timeseries Plot of Variables Used for the McCallum Rule Estimation



Source: CBSL, DCS

Exchange rate variation, on the other hand, weakly resembles the mirror image of the monetary aggregate dynamics curves, particularly the Narrow Money Growth (M1G) curve. This again makes sense as lower growth in the monetary base implies tightening the monetary policy stance which leads to appreciation pressure (or slowing down depreciation) in the exchange rate. None of the two figures seems to suggest any data issues such as discontinuities, outliers or changing variability.

If some variables to be included in the equations are stationary while others are not, taking first-difference or de-trending is useful to prevent possible spurious correlation problems. When the data series is not sufficiently long enough, however, the unit roots tests such as Augmented Dickey-Fuller or Phillips-Perron tests are not strong enough to distinguish between a series having a unit roots issue and a series with slow mean-reverting[35] property. Accordingly, these tests could be biased towards non-rejecting the null hypothesis of unit root for data series with short sample periods. The present study contains data series with 72 data points which is sufficiently long enough to check possible non-stationarities. Visually, none of the data plots seem to suggest any non-stationarities. It is, however, formally tested with the Augmented Dickey-Fully test and the results are given in the Table 2.

[35] A mean-reverting time series is normally stationary since the finite variance assures that a drift in data will revert before long, without moving far away from its mean.

Table 2: Stationarity of Variables (Unit root test)

Variable	ADF Test (Reported values)	
	t-Statistic	Probability*
$AWCMR(i_t)$	-2.947295	0.0450
$TBR(i_t)$	-2.770401	0.0676
$INFGAP\ (\pi_t - \pi^*)$	-3.988917	0.0025
$YGAP(y_t - \tilde{y}_t)$	-3.821691	0.0042
$EXRVAR(\Delta e_t)$	-5.718961	0.0000
$NDGPG(\Delta x_t)$	-3.366251	0.0156
$ARMG(\Delta m_t)$	-3.171793	0.0261
$M1G(\Delta m_t)$	-3.389851	0.0147

*MacKinnon (1996) one-sided p-values.

As evident from Table 2, all the necessary variables, except the Treasury bill rate, are stationary at 5 percent level of significance. The Treasury bill rate is also stationary at 10 percent level of significance and therefore data are free from any non-stationarity issues. This stationarity of the data is attributable to the fact that all of them, except nominal interest rates, are either in the gap-form[36] or in the first-difference form, implying that they are de-trended and thus stationary. Interestingly, all the variables which need to be used in estimating the policy rules mentioned above are stationary and do not show any data issues such as outliers, breakages and increasing/decreasing volatility.

4.2 Results and discussion

The different monetary policy reaction functions discussed above are estimated with Sri Lankan data. Following Clarida et al. (1998b), the policy rules and parameters are estimated with the ordinary least squares (OLS) method for contemporaneous and backward-looking policy rules while generalised method of moments (GMM) is utilized in the forward-looking specifications.

4.2.1 Taylor rule estimation

For the Taylor rule, two alternative policy instruments AWCMR and TBR are used for each of the three functional forms. The results are summarised in Appendix A.[37]

[36] i.e. Expressed either as a difference of the corresponding target value or long-term trend value.

[37] Results are presented in three individual tables for the contemporaneous, backward-looking and forward-looking cases.

Contemporaneous specification

The results of the contemporaneous Taylor rule specifications are summarised in Appendix A.1. The baseline scenario, where contemporaneous values of inflation, output gap and the first lag of the short-term interest rate[38] respond to the policy rules AWCMR and TBR, are shown in columns 2 and 4 of the table, respectively. The same rule, however, augmented with nominal exchange rate is also tested and the corresponding results are shown in columns 3 and 5 of the same table.

Interestingly, the results show that almost all of the coefficients in the four specifications of the contemporaneous case are highly significant. The inflation and output coefficients have the correct positive sign with both policy variables, AWCMR and TBR. The magnitude of the inflation coefficient is moderate and less than unity in all four cases. The highest value of the long-run inflation coefficient reported with TBR as the policy instrument is only 0.68. The fact that the contemporaneous specification disregards intrinsic lag in the monetary policy transmission mechanism,[39] could be partly attributable to this moderate value.

The coefficient of the output gap, in comparison, is larger and the corresponding long-run coefficients are greater than unity. The output-gap coefficient, which is larger than the inflation coefficient, suggests that the CBSL conducts monetary policy giving greater prominence to output stabilisation than inflation. Alternatively, it could be due to the lower sensitivity of output to the nominal interest rate which stipulates an aggressive response of the monetary policy in stabilising output, as argued in Hayo and Hofmann (2006).[40] It could also imply possible inaccuracies in computing the latent variable, the output gap, as highlighted in Taylor (1999b). This requires careful attention since academic literature, including McCallum (2001), argues that it is undesirable to respond to the output gap strongly.

The CBSL smooths out the interest rate strongly, as suggested by the reported high and significant value for the interest rate persistence parameter in all four specifications and this is in line with the previous findings of the studies conducted in Sri Lanka such as Perera and Jayawickrema (2013). This suggests that CBSL conducts monetary policy, making interest rate changes smoothly in small short steps in the desired direction, rather

[38] This is to account for the interest rate smoothing behaviour of the central bank.

[39] There are a few Sri Lankan studies such as Amarasekara (2005), Perera and Wickramanayake (2013) and Ghazanchyan (2014) that suggest the existence of a lag in monetary policy transmission mechanism.

[40] In a paper that compares the European Central Bank's (ECB) conduct of monetary policy with that of the Bundesbank, Hayo and Hofmann (2006) show that the relatively stronger reaction of the ECB to deviations of output from trend may be attributed to a lower interest rate sensitivity of output in the Euro area compared to Germany, rather than to differences in the policy preferences of the ECB and the Bundesbank. A similar behaviour is reported in the recent papers, Patra and Kapur (2012) and Perera and Jayawickrema (2013) as well.

than making immediate abrupt changes. This is a precautionary measure followed by many monetary authorities to mitigate possible risks in changing the policy stance under uncertain macroeconomic environments.

These findings also show that the CBSL does respond to the exchange rate, though not very strongly, as reflected by the long-run exchange rate coefficient of 0.3, which is statistically significant. As Sri Lanka is a small open economy exposed to foreign shocks, it is sensible to expect that the CBSL responds to the exchange rate in conducting monetary policy. All specifications are associated with fairly high R-squared statistics,[41] implying that observed data fits with the regression line satisfactorily and this is particularly visible where the policy instrument is the Treasury bill rate (TBR).

Backward-looking specification

Appendix A.2 summarises the estimation results for the backward-looking specification of the Taylor rule. Resembling Table A.1, the results for the baseline scenario, with AWCMR and TBR as the policy instruments, is shown in columns 2 and 4 of the table, while the results for the rule augmented with exchange rate are depicted in columns 2 and 4 respectively.

In contrast to the contemporaneous case, the inflation coefficient is statistically insignificant with AWCMR and smaller in magnitude in all specifications. The output gap coefficient is still greater than one and very significant. Exchange rate responsiveness has declined marginally and the figures are statistically insignificant as opposed to the contemporaneous case. Interest rate smoothing is strong and significant and the strength of smoothing is similar to in the previous case. The regression is not very different to that of the contemporaneous case as suggested by the adjusted R-squared statistic. The overall implications of the backward-looking specification do not seem to be very rational, as it implies that the CBSL neither responds to inflation nor to exchange rate in some specifications, as reflected by the small and significant coefficients.

Forward-looking specification

Appendix A.3 summarises the results for the forward-looking specifications. The two alternative short-term interest rates AWCMR and TBR are used as the policy instruments,

[41] R-squared statistics should, however, be used with caution due to two potential problems: firstly, the R-squared increases every time a predictor is added to a model and secondly over fitting the model may produce misleading R-squared statistics.

which is similar to the previous case, however, with one quarter ahead values of inflation, output gap and exchange rate change, as opposed to the previous two cases. The coefficients on inflation, output gap and exchange rate have the right positive sign and the values are statistically significant in all forward-looking specifications. Interestingly, the long-run inflation coefficient is larger than unity when the policy instrument is TBR.[42] Similarly, to the contemporaneous and backward-looking specifications, the output coefficient is large and strongly significant. Further, the exchange rate coefficient has the right sign; however, it is only significant when AWCMR is the instrument. Analogous to the contemporaneous and backward-looking cases, interest rate smoothing is high and significant in all the forward-looking specifications.

4.2.2 McCallum rule estimation

This study uses both the backward-looking and forward-looking versions of the McCallum rule, augmented with responses to exchange rate dynamics.[43] There is an important difference between the estimation of the McCallum rule and the Taylor rule, with regards to the output growth term: the McCallum rule defines the output growth term as the trend growth minus the actual growth. This is in contrast to the Taylor rule which defines the term as actual growth minus trend growth. Thus, a positive coefficient is expected for the output growth term in the McCallum rule, which can be sensibly interpreted as when the gap increases (i.e. actual output growth is lower than the trend growth), the rule advocates for an expansion in base money, and vice-versa.

In line with related literature, including McCallum (2000) and Patra and Kapur (2012), the target value of the nominal GDP growth for Sri Lanka is taken as 10.3 percent. This is the summation of the target value of inflation (i.e. 5 percent for Sri Lanka, as in the Taylor rule estimation) and the average real GDP growth rate for the country in the last 12 years, which is 5.3 percent.[44]

Backward-looking specification

Appendix A.4 summarises the results for the backward-looking specification of the McCallum rule. Positive and statistically significant coefficient values are obtained for the output growth when the policy instrument is M1G. These coefficients are estimated to be 0.25 and 0.24 respectively for the specifications with and without the exchange rate. McCallum

[42] Satisfying this condition is required in achieving determinacy in a closed economy policy rule which does not respond to output gap, as per Taylor (1999a). In the present case, however, the conditions are different.
[43] The original McCallum rule is of backward-looking form and I estimate an alternative forward-looking specification, following Patra and Kapur (2012).
[44] Computed for the period 2000 to 2012

suggests a range of values from 0.25 to 0.5 for this coefficient for mature economies and proposes slightly lower values for developing economies. Thus, the results obtained are consistent with McCallum's specification. When the policy instrument is the adjusted reserve money growth rate (ARMG), however, the corresponding coefficients are smaller (0.12 and 0.10 respectively) and are statistically insignificant. The coefficient on the exchange rate is correctly signed but small and insignificant, implying that the CBSL does not respond to exchange rate changes strongly in conducting the monetary policy. Moreover, all four specifications indicate strong policy smoothing which is more evident with the growth rate of monetary aggregate M1 with a coefficient of 0.82. Results suggest that where the policy instrument is M1G, the backward-looking McCallum rule explains monetary policy reaction behaviour in Sri Lanka better compared to that of ARMG, as evident from the higher R squared value together with the lower standard error of regression.

Forward-looking specification

The results for the forward-looking form of the McCallum rule[45] are summarised in Appendix A.3. The sign of the coefficient on the output growth is correct, but the value is insignificant when the policy instrument is ARMG. Similarly, the coefficient of the exchange rate is statistically not different from zero when the policy instrument is ARMG. When M1G is used as the instrument, however, both these coefficients are marginally significant at 10 percent level of significance, with fairly large magnitudes of 0.39 and 0.41 for the output growth coefficient and -0.34 for the exchange rate coefficient.

Similar to the backward-looking case, policy smoothing is strong and significant in all four specifications. Large standard errors of the regression in the McCallum rule models compared to the Taylor rule specifications suggest that the fitted values deviate considerably from their actual, which is not a desirable feature.

Actual and fitted policy response

Selecting the best model among the alternatives is an important part of any statistical analysis. This is relevant here since I am interested in identifying the rule which explains the monetary policy behaviour in Sri Lanka most reasonably. Many authors, including Bozdogan (1987), Hurvich and Tsai (1989) Raftery (1995) and Kadane and Lazar (2004), have examined the question of model selection and suggest several tools for selecting

[45] Estimation in the forward-looking specification employs GMM methodology, using the first lag of the following variables as instruments: ARMG, M1G, NGDPG and EXRVAR.

the best model. Among these criteria, residual sum of squares (RSS), standard error of regression (SE), Akaike information criterion (AIC), Schwartz information criterion (SC) and Hannan-Quinn information criteria (HQ) are widely used in academic literature. A ranking of the models based on the RSS and SE is reported in Table 3 below.[46] The RSS reports the squared value of the difference between actual and fitted, while SE reports the square root of RSS after dividing it by the effective degrees of freedom. Hence a model associated with a lower RSS and SE is preferred over a model with larger RSS and SE. In addition, a F-test is performed to check whether there is a significant difference between the model that includes exchange rate and the corresponding model that excludes exchange rate (EXRVAR), in each of the scenarios. For this purpose, the model without EXRVAR is treated as the unrestricted model while the one without EXRVAR is treated as the restricted model and performed the F-test as outlined in Wooldridge (2009). Accordingly, the F-statistic, $F = \frac{(SSR_r - SSR_{ur})/q}{SSR_{ur}/(n-k-1)}$, where SSR_r, SSR_{ur}, q, n and k represent Residual Sum of Squares of the restricted model, Residual Sum of Squares of the unrestricted model, the number of restrictions imposed, the total number of observations and the total number of independent variables in the model, respectively.

Table 3 leads to several important insights. Firstly, it suggests that the backward-looking and contemporaneous specifications outperform the forward-looking specifications, hence it does not support the idea that the CBSL was following a forward-looking monetary policy rule during the period under consideration. Secondly, the results imply that the growth rate of narrow money (M1G) is better than adjusted reserve money growth (ARMG) in characterizing the McCallum rule. Thirdly, it is found that the Treasury bill rate (TBR) is always better than the average weighted call money rate (AWCMR) in characterising the Taylor rule in all three specifications: contemporaneous, backward-looking and forward-looking. This suggests that the CBSL takes the movements of the Treasury bill rate into account more seriously than the movements in the call money rate in conducting the monetary policy. Fourth, in almost all Taylor rules, the specification with the exchange rate variation outperforms the corresponding rule without the exchange rate variation. This implies that the exchange rate variation has some explanatory power in describing the policy reaction. This equally says that the CBSL does respond to exchange rate variations in conducting monetary policy. Finally, the results depict that the contemporaneous Taylor rule where TBR responds to inflation, output gap and exchange rate variation explains the monetary policy reaction most appropriately among the alternative rules.

[46] These two criteria are used due to their simple and transparent nature. It is also noted that AIC, SC and HQ also give similar rankings as RSS and SE with respect to these models

Table 3: Model selection

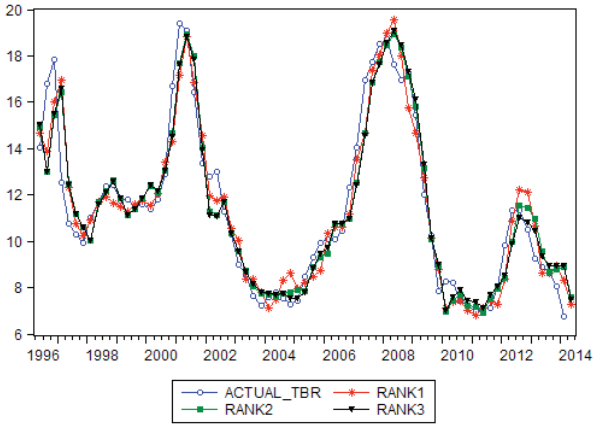
Rule				RSS	SE	F-test calcu.	Rank
Taylor	Contemporaneous	AWCMR	With EXRVAR	243.152	1.891	4.26**	7
			Without EXRVAR	258.626	1.936		9
		TBR	With EXRVAR	89.992	1.150	6.83**	1
			Without EXRVAR	99.161	1.199		4
	Backward	AWCMR	With EXRVAR	252.060	1.925	2.30	8
			Without EXRVAR	260.730	1.944		10
		TBR	With EXRVAR	96.178	1.189	1.44	2
			Without EXRVAR	98.238	1.193		3
	Forward	AWCMR	With EXRVAR	260.677	1.972	3.14*	11
			Without EXRVAR	272.881	2.003		12
		TBR	With EXRVAR	115.722	1.314	5.53**	5
			Without EXRVAR	125.366	1.358		6
McCallum	Backward	ARMG	With EXRVAR	1829.532	5.305	0.54	6
			Without EXRVAR	1844.396	5.286		5
		M1G	With EXRVAR	1211.460	4.317	0.03	2
			Without EXRVAR	1212.004	4.285		1
	Forward	ARMG	With EXRVAR	1914.005	5.469	0.60	8
			Without EXRVAR	1931.266	5.451		7
		M1G	With EXRVAR	1235.887	4.394	16.39**	3
			Without EXRVAR	1538.126	4.865		4

RSS: residual sum of squares, SE: standard error of regression.
F-test shows the calculated values of the test statistics; ***p < 0.01, **p < 0.05, *p < 0.1.

The fitted values of the best three rules together with the corresponding actual policy instruments are given in Figures 5 and 6, for both the Taylor and McCallum rules.

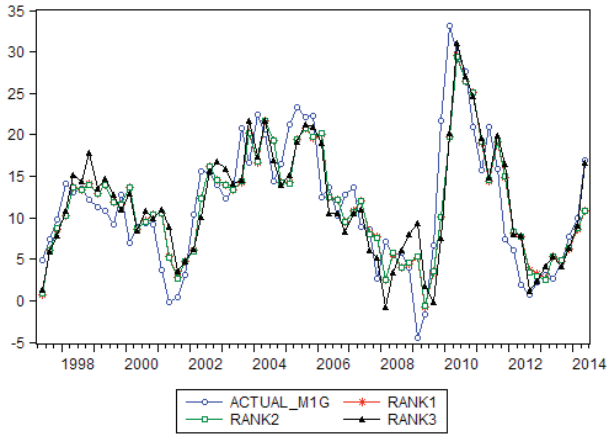
Figure 5 shows that the alternative rules match the actual short-term interest rate dynamics fairly well. Discrepancies among the three alternative rules are also not large. The fitted values slightly lag behind the actuals in the beginning of the period, however, the magnitude is small. In the first two peaks, which occurred in 1996 and 2001, the actual figures are slightly sharper than the fitted values. In line with the argument made in McCallum (2000), this could imply that the CBSL responds more aggressively than suggested by the rule. The reversal effects, where actuals are lower than the level advocated by the rules, are observed in the peaks in 2008 and 2012.

Figure 5: Actual TBR and the fitted values of the same with the best three Taylor rules



Source: CBSL and author's computations

Figure 6: Actual monetary base growth rate (M1G) and the fitted values of the same with the best three McCallum rules



Source: CBSL and author's computations

As reflected by Figure 6 and Table 3, the residual gaps between actuals and fitted values are larger in the McCallum rule, suggesting that it is less suited for explaining the monetary policy reaction in Sri Lanka than the Taylor rule. The question of whether a policy rule proposed is

associated with a unique determinate solution is an important consideration in deciding on the most suitable alternative policy rule among several alternatives (Bernanke and Woodford, 1997; Clarida et al., 1998a; Bullard and Mitra, 2002; Bullard and Mitra, 2007). For a simple interest rate feedback rule of the form $i_t = \bar{\imath}_t + \emptyset_\pi \pi_t$, Woodford (2003) shows that the rational-expectations equilibrium paths of inflation and nominal interest rate are determinate when the inflation coefficient $\emptyset_\pi > 1$ and are indeterminate, if instead $0 \leq \emptyset_\pi < 1$. He further shows that when interest rate smoothing presents, equilibrium is determinate if and only if $\emptyset_\pi/(1-\rho) > 1$ where ϱ is the smoothing parameter. Accordingly, he interprets this condition as the case where an eventual increase in the nominal interest rate as a result of the sustained increase in the inflation rate is more than one-for-one. In an open economy version of the policy rule that is similar to the one I consider in the study, the determinacy condition is more complex and depends on the other parameters of the economy as argued in Gali (2009) and Araujo (2014), for instance.

4.3 Endogeneity and Attenuation bias concerns

Estimation of monetary policy rules using the ordinary least squares (OLS) method could sometimes lead to potentially inconsistent estimates of policy parameters due to the issue of endogeneity. Monetary authorities respond to variables such as inflation, output gap and exchange rate that are endogenous to monetary policy shocks. Endogeneity arises as a result of a correlation between explanatory variables and the error term, thus creating a bias. Although Instrumental Variables (IV) are usually employed to address this issue,[47] the validity of such potential variables depends on various unobserved factors of the economic environment. Thus, among others, Carvalho et al (2018) argue in favor of OLS estimation of monetary policy rules. They maintain that the endogeneity bias is small since monetary policy shocks explain only a small fraction of the variance of regressors typically included in monetary policy rules. Further, using simulations, they show that, for realistic sample sizes, the OLS estimator of monetary policy parameters outperforms IV estimators. Accordingly, this study limits the analysis to OLS estimation of monetary policy rules only.

The expected variables in forward-looking specifications of the rules are approximated by the leads of the corresponding observed variables. This could possibly lead to attenuation bias, arising from possible measurement errors,[48] either in dependent or explanatory variables. Attenuation bias influences an estimator toward zero and accordingly the magnitude of an estimator with attenuation bias is smaller in magnitude than the absolute value of the

[47] See for instance, Clarida, Gali and Gertler (2000)

[48] Measurement error refers to a situation where the true empirical value of a variable cannot be observed or measured with a precise degree of accuracy. Accordingly, the error is the difference between the actual value of that variable and what can be observed or measured

parameter.[49] However, in the present study, the number of observations used to compute data points for certain variables such as for AWCMR, etc. are substantially high. Further, the true empirical value of some variables such as the Treasury bill rate is observable and measurable. Accordingly, the likelihood of attenuation bias seems to be negligible in the present study and adjusting for attenuation bias cannot be found in the literature on monetary policy rules.

5. Conclusion

This paper empirically assesses the appropriateness of the Taylor rule and the McCallum rule in characterising the monetary policy conduct behaviour in Sri Lanka. It regards the two approaches as alternatives, rather than as competing rivals. Over the last two decades, the Taylor rule has gained more recognition and become the most widely used policy rule in the central banks of the world, owing to its ability to describe modern monetary policy more sensibly than alternative rules. Testing both of these policy rules is, however, important in the Sri Lankan context since the CBSL still uses broad money as an indicative intermediate variable in the conduct of monetary policy, although interest rate (AWCMR) is the main monetary policy instrument.

The empirical results suggest that the backward-looking and contemporaneous specifications outperform the forward-looking specifications and therefore the findings do not support the idea that the CBSL followed a forward-looking monetary policy rule during the period under consideration. Results also suggest that the movements of the Treasury bill rate explain the conduct of the monetary policy better than the call money rate (AWCMR). Moreover, it implies that the CBSL does respond to exchange rate variations in conducting monetary policy. It is also found that the CBSL is strongly smoothing out policy action, as it implements policy action in small steps in the desired direction without making abrupt changes to alleviate possible risks that could hamper the economy otherwise. A considerably larger output gap coefficient, in comparison to the inflation coefficient is notable. This, however, could be due to lower sensitivity of output to interest rate or alternatively due to the inaccuracies in determining the unobservable output gap. Therefore, further investigation is needed to find out such possibilities in explaining this difference. The results suggest that the contemporaneous Taylor rule, where TBR responds to inflation, output gap and exchange rate variation, explains the monetary policy reaction most appropriately among the alternative rules.

Some studies find that monetary policy reaction does not take exchange rate changes into account, as opposed to the findings of the present study. Taylor and Williams (2010), for instance, find that the interest rate rules which react to exchange rate underperforms those that do not. Moreover, Taylor (2001) argues that the inclusion of exchange rate in

[49] For details see Wooldridge, J.M., (2003), Introductory Econometrics, 2nd ed., Thomson.

the policy rule could lead to a deterioration of output performance. Thus, the response of the CBSL to exchange rate variations in conducting monetary policy might not be optimal. In-depth investigations are, however, needed to establish this stance in the Sri Lankan context.

When monetary policy is conducted without a rule, policymakers have a bias towards inflationary monetary policy; however, if they are bound to follow a rule, inflation would be lower (McCallum, 1990; Stark and Croushore, 1998 and Taylor and Williams, 2010). An important conjecture highlighted by McCallum (1999a) and Woodford (2001a) is, however, that the policy rules would not need to be followed literally or slavishly by the monetary authorities; instead, such rules can be used for indicative purposes, probably as a starting point for policy discussions and recommendations.

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Appendices

A1 Case 1: The contemporaneous Taylor rule

$$i_t = \emptyset_0 + \emptyset_\pi(\pi_t - \pi^*) + \emptyset_y ygap_t + \emptyset_e \Delta e_t + \emptyset_i i_{t-1} + \varepsilon_t$$

Table A1: Summary statistics for the contemporaneous Taylor rule

Description	Policy instrument			
	Call Money (AWCMR)		T-bill (TBR)	
	Including exchange rate	Excluding exchange rate	Including exchange rate	Excluding exchange rate
Parameters estimates				
Constant ($\emptyset_0$)	2.52	2.30	1.38	1.15
	(3.26)***	(2.93)***	(2.74)***	(2.22)**
INFGAP ($\emptyset_\pi$)	0.16	0.13	0.13	0.10
	(3.07)***	(2.54)**	(3.72)***	(2.91)***
YGAP ($\emptyset_y$)	0.49	0.45	0.50	0.43
	(3.19)***	(2.89)***	(4.80)***	(4.51)***
EXRVAR ($\emptyset_e$)	0.10	-	0.07	-
	(2.08)**	-	(2.63)**	-
AWCMR(-1) ($\emptyset_i$)	0.68	-0.74	-	-
	(8.71)***	(10.23)***	-	-
TBR(-1) ($\emptyset_i$)	-	-	0.79	0.85
	-	-	(14.55)***	(16.63)***
Estimation method	OLS	OLS	OLS	OLS
Observations	73	73	73	73
Adjusted R-squared	0.74	0.73	0.90	0.89
SE of regression	1.89	1.94	1.15	1.20
F-statistics	53.67	66.89	159.07	193.19
Prob. (F-statistics)	0.00	0.00	0.00	0.00
Long-run coefficient				
Inflation	0.51	0.52	0.63	0.68
Output	1.52	1.76	2.10	2.81
Exchange rate	0.30	-	0.35	-

Notes: t-statistics are in the parenthesis, ****p < 0.01, **p < 0.05, *p < 0.1.*

The long-run coefficients are computed as per Woodford (2001b), for instance, *the long run coefficient of inflation = inflation coefficient/ (1-interest rate smoothing coefficient),* and so on.

A2 Case 2: The backward-looking Taylor rule

$$i_t = \emptyset_0 + \emptyset_\pi(\pi_{t-1} - \pi^*) + \emptyset_y ygap_{t-1} + \emptyset_e \Delta e_{t-1} + \emptyset_i i_{t-1} + \varepsilon_t$$

Table A2: Summary statistics for the backward-looking Taylor rule

Description		Policy instrument			
		Call Money (AWCMR)		T-bill (TBR)	
		Including exchange rate	Excluding exchange rate	Including exchange rate	Excluding exchange rate
Parameters estimates					
Constant	$(\emptyset_0)$	2.87	2.62	1.56	1.39
		(3.50)***	(3.23)***	(2.86)***	(2.63)**
INFGAP(-1)	$(\emptyset_\pi)$	0.10	0.07	0.07	0.06
		(1.75)*	(1.3)	(1.86)*	(1.49)
YGAP(-1)	$(\emptyset_y)$	0.65	0.59	0.56	0.53
		(3.97)***	(3.68)***	(5.64)***	(5.49)***
EXRVAR(-1)	$(\emptyset_e)$	0.07	-	0.04	-
		(1.53)	-	(1.21)	-
AWCMR(-1)	$(\emptyset_i)$	0.68	-0.74	-	-
		(7.99)***	(9.70)***	-	-
TBR(-1)	$(\emptyset_i)$	-	-	0.81	0.85
		-	-	(13.17)***	(15.86)***
Estimation method		OLS	OLS	OLS	OLS
Observations		73	73	73	73
Adjusted R-squared		0.73	0.73	0.89	0.89
SE of regression		1.93	1.94	1.19	1.19
F-statistics		51.17	66.17	147.75	195.22
Prob. (F-statistics)		0.00	0.00	0.00	0.00
Long-run coefficient					
Inflation		0.32	0.27	0.39	0.36
Output		2.04	2.27	0.92	3.45
Exchange rate		0.23	-	0.19	-

Notes: t-statistics are in the parenthesis, ****p < 0.01, **p < 0.05, *p < 0.1.*

The long-run coefficients are computed as per Woodford (2001b), for instance, *the long run coefficient of inflation = inflation coefficient/ (1-interest rate smoothing coefficient),* and so on.

A3 Case 3: The forward-looking Taylor rule

$$i_t = \emptyset_0 + \emptyset_\pi(E_t[\pi_{t+1}] - \pi^*) + \emptyset_y E_t[ygap_{t+1}] + \emptyset_e E_t \Delta e_{t+1} + \emptyset_i i_{t-1} + \varepsilon_t$$

Table A3: Summary statistics for the forward-looking Taylor rule

Description		Policy instrument			
		Call Money (AWCMR)		T-bill (TBR)	
		Including exchange rate	Excluding exchange rate	Including exchange rate	Excluding exchange rate
Parameters estimates					
Constant	$(\emptyset_0)$	1.67	2.92	1.18	1.15
		(2.06)**	(2.86)***	(1.90)*	(1.82)*
INFGAP(+1)	$(\emptyset_\pi)$	0.26	0.19	0.22	0.20
		(2.99)***	(3.71)***	(3.26)***	(5.30)***
YGAP(+1)	$(\emptyset_y)$	0.62	0.49	0.54	0.55
		(3.18)***	(1.75)*	(3.54)***	(3.65)***
EXRVAR(+1)	$(\emptyset_e)$	0.12	-	0.03	-
		(1.86)*	-	(0.37)	-
AWCMR(-1)	$(\emptyset_i)$	0.71	0.69	-	-
		(7.82)***	(7.08)***	-	-
TBR(-1)	$(\emptyset_i)$	-	-	0.78	0.81
		-	-	(8.51)***	(12.99)***
Estimation method		GMM	GMM	GMM	GMM
Observations		72	72	72	72
Adjusted R-squared		0.72	0.72	0.86	0.86
SE of regression		1.97	2.00	1.31	1.36
J-statistics		0.40	2.36	0.47	0.53
Prob. (J-statistics)		0.52	0.31	0.49	0.76
Long-run coefficient					
Inflation		0.89	0.61	1.00	1.02
Output		2.11	1.58	2.50	2.84
Exchange rate		0.40	-	0.15	-

Notes: t-statistics are in the parenthesis, ****p < 0.01, **p < 0.05, *p < 0.1.*

Instruments for the GMM estimate: INFGAP(-1), YGAP(-1), AWCMR(-1), TBR(-1) AN EXRVAR(-1)..

J-test reports p-value for test for over-identifying restrictions for GMM estimates.

The long-run coefficients are computed as per Woodford (2001b), for instance, *the long run coefficient of inflation = inflation coefficient/(1-interest rate smoothing coefficient),* and so on.

A4 Case 4: The backward-looking McCallum rule

$$\Delta m_t = c_1 + c_2(\Delta x^* - x_{t-1}) + c_3 \Delta e_{t-1} + c_4 \Delta m_{t-1} + \varepsilon_t$$

Table A4: Summary statistics for the backward-looking McCallum rule

Description		Policy instrument			
		Reserve Money (ARMG)		M1growth (M1G)	
		Including exchange rate	Excluding exchange rate	Including exchange rate	Excluding exchange rate
Parameters estimates					
Constant	(c_1)	4.02	3.43	3.59	3.39
		(2.97)***	(3.17)***	(2.39)**	(3.32)***
(TGT-NGDPG(-1))	(c_2)	0.12	0.10	0.25	0.24
		(0.41)	(0.49)	(2.11)**	(2.15)**
EXRVAR(-1)	(c_3)	-0.09	-	-0.21	-
		(-0.73)	-	(-0.18)	-
EXRVAR(-1)	(c_4)	0.75	0.75	-	-
		(9.73)***	(9.94)***	-	-
AWCMR(-1)	(c_4)	-	-	0.82	0.82
		-	-	(10.46)***	(12.33)***
Estimation method		OLS	OLS	OLS	OLS
Observations		69	69	69	69
Adjusted R-squared		0.60	0.60	0.68	0.69
SE of regression		5.31	5.29	4.32	4.28
F-statistics		35.28	53.03	50.31	76.57
Prob. (F-statistics)		0.00	0.00	0.00	0.00

Notes: t-statistics are in the parenthesis, ****p < 0.01, **p < 0.05, *p < 0.1.*

A5 Case 5: The forward-looking McCallum rule

$$\Delta m_t = c_1 + c_2(\Delta x^* - E_t x_{t+1}) + c_3 \Delta E_t e_{t+1} + c_4 \Delta m_{t-1} + \varepsilon_t$$

Table A5: Summary statistics for the forward-looking McCallum rule

Description		Policy instrument			
		Reserve Money (ARMG)		M1growth (M!G)	
		Including exchange rate	Excluding exchange rate	Including exchange rate	Excluding exchange rate
Parameters estimates					
Constant	(c_1)	5.83	2.18	6.10	3.39
		(2.45)**	(2.34)***	(3.55)***	(3.32)***
(TGT-NGDPG(-1))	(c_2)	0.17	0.09	0.39	0.24
		(0.56)	(0.40)	(1.94)*	(2.15)**
EXRVAR(-1)	(c_3)	-0.40	-	-0.34	-
		(-1.52)***	-	(-1.90)*	-
EXRVAR(-1)	(c_4)	0.77	0.85	-	-
		(4.47)***	(7.16)***	-	-
AWCMR(-1)	(c_4)	-	-	0.76	0.88
		-	-	(7.38)***	(14.16)***
Estimation method		GMM	GMM	GMM	GMM
Observations		68	68	69	69
Adjusted R-squared		0.60	0.60	0.68	0.68
SE of regression		5.47	5.45	4.39	4.86
J-statistics		0.86	3.73	0.67	1.18

Notes: t-statistics are in the parenthesis, ****p < 0.01, **p < 0.05, *p < 0.1.*

Effect of Exchange Rate Volatility on Sri Lanka's Inbound Tourist Flow

Gayani Ishara Rathnayake [1]

Abstract

This paper investigates effects of exchange rate volatility on Sri Lanka's inbound tourism using monthly data on tourist arrivals, exchange rate and other related variables from 1990 to 2016. An Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) model is used to generate a measure of exchange rate volatility. This is then incorporated in a tourism demand model to test its impact on tourist flows into the country. The empirical methodology depends on the theory of cointegration and error correction representation. The results reveal that there are significant negative short run and long run effects of exchange rate volatility on tourist flows to Sri Lanka. Further, it suggests that the Sri Lankan tourism product is a luxury good, having high income elasticity. In addition, tourism related inflation has a significant negative impact on the growth in tourist arrivals in the short run. However, in the long run, a reduction in price sensitivity is observed. Moreover, results highlight the significant positive impact of habit persistence or/and word of mouth recommendation in increasing tourist flows to Sri Lanka. It further reveals the importance of maintaining a conducive economic, political and social environment to increase the demand for Sri Lankan tourism.

***Key Words**: Exchange rate Volatility, Tourism Demand, Cointegration, Error Correction, EGARCH model, Sri Lanka*

***JEL Classification:** C32; F41; L83*

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1. Introduction

The year 2017 has been designated as the' International Year of Sustainable Tourism for Development' by the United Nations and it focuses on promoting the role of tourism in five key sectors, namely "inclusive and sustainable economic growth", "social inclusiveness, employment and poverty reduction", "resource efficiency, environmental protection and climate change", "cultural values, diversity and heritage", and "mutual understanding, peace and security" (United Nations World Tourism Organization (UNWTO) *International year for sustainable tourism*). This highlights the significance of the tourism industry, throughout the world, in promoting sustainable economic growth. According to the World Travel and Tourism Council (WTTC) the total contribution of travel and tourism to global GDP was estimated at 10.2% in 2016, while it accounted for 6.6% of total exports, generating one in ten jobs across the world (qtd. in UNWTO *Tourism highlights 2016*). In 2016, international tourist arrivals around the world recorded a robust growth rate of 3.9%, reaching 1,235 million tourist arrivals (UNWTO *Tourism highlights 2016*). Thus, reflecting the high growth potential in this sector, the 2030 vision of the UNWTO expects tourist arrivals to record a growth rate of 3.3% per year from 2010 to 2030 and reach 1.8 billion tourist arrivals by 2030. Accordingly, to capitalise on this growth potential many new tourist attraction destinations are adding in to this industry, increasing its competition.

In Sri Lanka, the tourism industry earned US dollars 3,518 million during 2016, recording a year on year growth rate of 18.0% (Central Bank of Sri Lanka (CBSL) *Annual Report 2016*). It plays a prominent role in the Sri Lankan economy through generating direct and indirect employment. In 2016, total estimated employment in the tourism industry was 335,659 (CBSL *Annual Report 2016*). Thus, developing the tourism sector is identified as one of the poverty reduction strategies. Sri Lankan tourism has been experiencing rapid growth and diversification especially in the post conflict era, achieving over 2 million tourist arrivals in 2016 when compared to 448,000 in 2009 (CBSL *Annual Report 2016*). According to the Ministry of Economic Development the target by 2020 is to achieve four million tourist arrivals along with US dollars 8 billion earnings, while generating one million employment opportunities (Ministry of economic Development *Tourism Development strategy*). Thus, authorities should develop policies to promote sustainable growth in this sector in order to achieve these targets. Therefore, when designing such policies, a clear understanding of the effect of exchange rate fluctuations on tourist flows into Sri Lanka is necessary together with an assessment of the impact of other tourism demand determinants. However, the effect of exchange rate volatility on Sri Lanka's inbound tourism (i.e. tourist flows to Sri Lanka) has not been adequately explored, highlighting a research gap, which lead to the research problem of this study.

According to the UNWTO, a visitor (domestic, inbound or outbound) is classified as a tourist (or overnight visitor) if his/her trip includes an overnight stay (UNWTO *International*

recommendations for tourism statistics). An Inbound tourist is defined as a foreigner or in other words a non-resident who visit a given country.

The exchange rate is formally defined as the number of units of one currency that can be exchanged for a unit of another (CBSL *Exchange Rate*). The nominal appreciation of an exchange rate is defined as a situation where the value of domestic currency increases with respect to a foreign currency and depreciation refers to the opposite relationship where the value of the domestic currency decreases with respect to a foreign currency. The exchange rate can be defined as either a nominal rate or a a real rate, where the real exchange rate is the nominal exchange rate adjusted to the purchasing power. Exchange rate regime refers to the method by which a country manages its exchange rate with respect to other countries around the world. There are two main exchange rate regimes found in literature, namely, the floating exchange rate regime and the fixed exchange rate regime, and there are intermediate exchange rates that lie between these two extremes. Most of the countries adopted the floating exchange rate regime after the breakdown of Bretton Woods agreement in 1973 and with this shift the impact of exchange rate volatility on international trade patterns has been a focal point of both theoretical and empirical investigators (Ozturk and Kalyoncu 499–513). In the current context, Sri Lanka follows an independently floating exchange rate regime (CBSL *Exchange Rate*).

Ozturk defined exchange rate volatility as the risk associated with unexpected movements in the exchange rate (Ozturk 85). However, the volatile exchange rate cannot be predicted with substantial accuracy since it indicates irregular changes. Furthermore, the association between tourism demand and exchange rate volatility is ambiguous. However, majority of empirical literature state that exchange rate volatility impacts tourist flows negatively since the choice of destination of risk averse tourists as well as travel agents is affected by the volatility of the exchange rate as they link it with uncertainty in social, political and economic environment in the destination country as well as it increases the transaction cost associated(Webber, 398–405). For instance, Webber revealed that 40% of the sample under his investigation changed the decision to visit a destination due to fluctuations observed in the exchange rate. In addition, tour operators will consider other competitive destinations to avoid markets that are prone to unusual exchange rate fluctuations since they consider it as a business portfolio risk. The UNWTO also highlights the fact that unusually strong exchange rate fluctuation is one of the three key factors that influenced tourism flows in 2015 (UNWTO *Tourism highlights 2016)*. This further highlights the significance of assessing the relationship between tourist flows into a country and exchange rate volatility.

With the conclusion of the approximately thirty years long civil war, Sri Lanka is recently experiencing a high growth in both foreign and domestic tourism. In the post conflict era, tourism is identified as a significant driver of economic growth in the country, where it became the third largest foreign income earner in 2015 (CBSL, *Annual report 2016*). According to the World Travel and Tourism Council (WTTC) statistics the Sri Lankan tourism sector's contribution to GDP and its employment generation capability remains high above the world

and Asian averages, however, it lags behind its competitors (qtd. in CBSL, *Annual report 2016*). According to the statistics published by the WTO for the year 2014, Sri Lanka's share of world tourist arrivals was 0.13 per cent which was only 0.2 per cent of total earnings from tourism in the world (qtd. in CBSL, *Annual report 2016*)). This reflects the enormous potential of Sri Lankan tourism industry to thrive in the future as well as its ability in narrowing the balance of payment deficit of the country through earning foreign income. Even though, inbound tourism is an important sector to the Sri Lankan economy very little research has been conducted focusing on this segment. Quite a few have focused the on tourism sector in Sri Lanka (Fernando et al. 575–586; Konarasinghe 57-63; Lelwala and Gunaratne 50-59; Selvanathan 35–38; Welgamage 90-101). However, no study has attempted to identify the effect of exchange rate volatility on Sri Lanka's inbound tourism, a notable gap this research attempts to bridge.

2. Literature review

2.1 Factors affecting tourism demand

The income of the origin country, relative prices between destination and origin, exchange rate, and transportation costs are identified as key influencing factors or explanatory variables of tourism demand in empirical literature (Agiomirgianakis et al., "Iceland" 25-34; Cheng 167–181; Dogru et al. 47-55; Patsouratis et al. 1865–1870; Peng et al. 611–633; Song and Li .203–220; Witt and Witt 447–475).

In most of the empirical research, tourism demand is measured by the number of tourist arrivals from an origin country to the foreign destination country (Song and Li, .203–220; Chu 1414–1420). Alternatively, certain studies employ tourism expenditure in the destination (Dogru et al. 47-55) as the proxy for tourism demand while others use tourism receipts (Akal 565-580) or expenditure of a particular product (Li et al. 57–71). These proxies are in line with theory, but different estimates may result depending on the proxy employed. However, Song et al. in their research concluded that tourism expenditure is a better proxy for demand than tourist arrivals (377-396). Nevertheless, it also depends on the objective of the research as well. Other indicators used, but rarely as a proxy for tourism demand, include tourist nights spent (Gouveia and Rodrigues 501 - 515), tourism employment (Witt, et al., 167 - 176) and length of stay (Gokovali, et al. 736–746).

2.1.1 Income of the origin country as a tourism demand determinant

Cheng based on his research concluded that international tourism is income elastic and thus is expected to be a luxury good in line with economic theory (167–181). Peng et al. further confirms this through a meta-analysis of studies published from 1960 to 2011, where the study revealed that the mean elasticity of tourism demand was 2.526 with a standard deviation of 3.065(611–633). This reflects that international tourism is in the "luxury" good category since income elasticity is greater than one in most of the empirical studies. Moreover, empirical

literature considers Income as the most influential demand determinant of tourism (Crouch, "Review", 12-23). According to Crouch, estimated income elasticity differs with various income proxies ("Income" 643-669). Further, according to Peng et al. it differs with the destination-origin combinations considered (611–633).

The personal disposal income is the most ideal variable for measuring income, but this is not generally available (Gonzalez and Moral 233-251). Thus, empirical literature frequently uses real or nominal per capita Gross Domestic Product (GDP), Gross National Income (GNI), private consumption or personal disposable income as a proxy for income (Agiomirgianakis et al., "Iceland" 25-34; Patsouratis et al. 1865–1870; Peng et al. 611–633). However, Witt and Witt state that the most appropriate proxy depends on the type of tourist visit considered, for instance, if business visits are under consideration, then more general income variables such as GNI or GDP will be appropriate and if holiday visits are under consideration, then a measure such as personal disposable income or private consumption will be appropriate (447–475). Industrial Production Index (IPI) is also used as an alternative measure (Gonzalez and Moral 233-251; Mwangi et al. 1-12) when considering monthly data, since the highest frequency of reporting GNI or GDP is quarterly or annual in some instances. Dogru et al. in their study investigated the adequacy of IPI and conclude that it is not adequate as an income proxy as it only reflects industrial developments and omits service-related growth (47-55). However, they state that IPI can be beneficial in dealing with high frequency monthly data, which may contain in depth information and they also state that the adequacy will also depend on the country specific characteristics and modelling technique employed.

2.1.2 Relative prices as a tourism demand determinant

Literature reveals that relative prices is also an important factor impacting the tourism demand (Lim "Determinants" 447-485, "Analytic Review" 273-284). Dwyer and Forsyth state that when considering the tourism price factor, it includes two main elements namely, cost of transport to and from destination and cost of living for tourist at destination (751-777). The most frequently used proxy for relative prices is the ratio of Consumer Price Index (CPI) between destination country and origin country adjusted to exchange rates (Falk 101–112). This assumes that the major determinant for the decision of foreign travel is whether to spend the holiday at a particular destination or at the origin or in other words in the home country. Further, prices paid will be influenced by the prevailing exchange rate (Dwyer and Forsyth 751-777). However, using CPI to compute a proxy for the relative price of tourism is at the centre of debate. Many researchers argue that the use of a CPI proxy has a major drawback as it does not reflect the products brought by, the tourist, since the basket of goods reflect the consumption pattern of an average household (Dwyer and Forsyth 751-777). Some researchers validate the use of CPI by assuming that the trend in prices of the basket of goods and services consumed by tourists have a tendency to move in line with general consumer prices. Nevertheless, Divisekera showed that this assumption does not hold in all cases (31-

49). Moreover, CPI lacks consistency between countries in terms of coverage and weights, and it only measures the change in price level so that no information is provided on actual price levels. Thus, to overcome these limitations, certain researchers propose using alternative customised tourism price variables like hotel price indices (Narayan 193 - 206.), separate tourism price index, service price index or index of price competitiveness (Dwyer and Forsyth 751-777). However, these can only be compiled through extensive data collection and processing, and in some instances, country specific definitions and computational methodologies will be an issue in cross country comparisons. Therefore, as highlighted by Pastorates et al. researchers continue to use CPI given the lack of data availability and timeliness of appropriate tourist specific price estimates (1865–1870). Witt and Witt state that any price measure that is used should be adjusted by the exchange rate to transform it to the currency of the origin country (447–475).

According to economic theory, the rise in price level results in a reduced demand for most of the goods and services (Crouch, "Review" 12-23; Crouch, "Survey" 41-55). Peng et al. in their "meta-analysis of International tourism demand elasticities" reveal that in empirical studies the estimated elasticity is negative, reflecting that increase in prices reduced tourist demand which is in line with economic theory (611–633). In particular, they found that overall average price elasticity to be -1.281 with a standard deviation of 1.818. However, if "country(s) represented in the denominator complement tourism to the destination in question, or the income effect is strong, the opposite may occur" (Crouch, "Demand Elasticities" 117-136). Thus, both positive and negative elasticity is possible. For example, Agiomirgianakis, et al. in their research on the effects of exchange rate volatility on tourist flows to the United Kingdom (UK) and Sweden conclude that price relative is positive or in some cases insignificant for UK, implying that the destination selection of the tourist visiting UK is independent of the price factor and conclude that tourists visit UK for the unique tourist product it offers("UK" 1-12). Dwyer and Forsyth state that with the high focus on destination differentiation strategies, the price sensitivity of the tourists has diminished over time (751-777).

Literature also reveals that the estimated price elasticity varies significantly depending on the origin- destination combinations considered. For example, Kraipornsak states that the international tourists coming to Thailand are highly sensitive to price where elasticity is estimated to be 3.0(93-108). In contrast, Schiff and Becken reveal that tourists visiting New Zealand from the UK, USA and Australia are not sensitive towards price levels where the price elasticity was estimated to be approximately -0.5(564-575). In addition, it is found that elasticity depends on the purpose of the trip. For instance, Crouch ("Effects of Income" 103-118) concludes that price elasticity is high in sun, sea and sand tourism compared to other types of tourism. Further, the Australian Bureau of Transport and Communications Economics finds that leisure travelers are more sensitive to price than business travelers. Apart from these factors, explanatory variables used, frequency of data, demand model used for modelling and

proxy used influence the estimated price elasticity (Crouch, "Income" 643-669; Crouch," Demand Elasticities" 117-136; Lim" Determinants" 447-485).

2.1.3 Exchange rate as a tourism demand determinant

Use of exchange rate as a determinant in the tourism demand model is controversial. Empirical literature reveals that exchange rate appreciation at the destination will deter tourist flows to that destination country (Patsouratis et al. 1865–18705; Dwyer and Forsyth 751-777). Some researchers introduce the exchange rate as a separate factor since tourists are mindful of exchange rates than cost of living in the country visited and tour operators use exchange rate hedging (Patsouratis et al. 1865–1870), while others use the exchange rate only to standardise relative prices (Song and Witt, 214–224). In literature it is argued that since tourists are more aware about the exchange rate, they base their travel decisions on that Yap claims that exchange rate is a more representative measure of tourist's cost of living when compared to consumer price indices (111-132). However, exchange rate alone is not a satisfactory proxy for relative prices as favourable exchange rate may be a result of high inflation (Witt and Witt, 447–475). This is further confirmed by De Vita and Kyaw where they revealed that the exchange rate alone is not a significant factor effecting tourism demand, but relative prices adjusted by exchange rate is a significant factor (624-627). The studies that include an additional exchange rate variable apart from the price relative sometimes face issues such as multicollearity and modelling bias. For instance, Dogru et al. in their research revealed that there is an almost perfect negative correlation that is estimated to be 0.99 between exchange rate and relative prices standardized by the exchange rate (47-55). Thus, they concluded that including an exchange rate in addition to relative prices standardized by the exchange rate is undesirable and they recommended only using relative prices standardized by the exchange rate as a measure of tourist's cost of living at destination.

2.1.4 Transport cost as a tourism demand determinant

Airline ticket prices, travel distance and fuel cost are usually used to measure the transportation cost (Turner and Witt, 2001; Peng, et al., 611–633). Agiomirgianakis et al. ("Turkey" 700-725) state that cost of travelling to a specific country adversely impacts the tourist flow to that country but the study carried out by Lim (Lim "Determinants" 447-485) does not fully support this relationship. However, Witt and Witt states that due to the complexity of constructing a proxy with the available data and possible multicollinearity issues most of the researchers drop this factor from the tourism demand model (447–475).

2.1.5 Other determinant considered in tourism demand models

Other determinants considered include substitute prices of competitive destinations (Dogru et al. 47-55), trend and marketing expenditure (Crouch, "Survey" 41-55), dummy variables to capture the effects of seasonality (Agiomirgianakis et al., "Turkey" 700-725) as well as to

capture the impact of special incidents (Song, et al. 63-81). Moreover, Peng, et al., identify variables such as foreign direct investment education level of tourists, destination promotional expenditure, immigration patterns and climate changes which are also occasionally used in tourism demand models (611–633).

2.2 Relationship between tourist flows and volatility in the exchange rate

Exchange rate volatility can be included as an additional variable in the tourism demand model to reflect the aspect of "uncertainty avoidance" when selecting the travel destination (De Vita and Kyaw 624-627).

Song and Witt state that the real exchange rate captures two effects of international tourism prices, which is the effect of nominal exchange rate as well as the impact of the relative prices. Further, they state that the association between the tourism demand and exchange rate volatility is expected to be negative as exchange rate volatility increase uncertainty as well as transaction cost associated with travelling abroad. This is further confirmed by Agiomirgianakisa, et al. in their research on "The Effects of Exchange Rate Volatility on Tourist Flows: Evidence from the UK and Sweden" where they reveal that for the UK there is a negative impact from exchange rate volatility on tourist arrivals indicating that tourist as well as travel agents respond to even small fluctuations in the exchange rate ("UK" 1-12). Further, they argue that for Sweden, exchange rate volatility of three per cent above or below the average has an adverse impact on potential tourists and travel agents. However, minor deviations in the exchange rate have no significant impact on tourist flows.

Agiomirgianakis et al. state that political or economic instability and social unrests in the destination country are also reflected through a volatile exchange rate apart from the changes in relative prices ("Turkey" 700-725). In this study, they find that there is a strong negative statistically significant effect of "exchange rate volatility" on tourist flows into Turkey. Further, they concluded that an increase in volatility reduces tourist arrivals more than proportionately, indicating that high volatility has a greater influence on the decision of tourists as well as tour operators whereas smaller changes have a lesser impact. This negative relationship among exchange rate volatility and tourism demand in Turkey is also confirmed by Aktaş and Özkan, where they use tourism revenue as a proxy for tourism demand (493-499). However, they concluded that the relationship is weak in the long run. Moreover, Agiomirgianakisa et al. revealed that this relationship holds for Iceland as well ("Iceland" 25-34). Saayman and Saayman in their study argue that exchange rate volatility significantly influences tourist expenditure and arrivals in South Africa (104-121). Peace et al. in their study find that a similar trend is observed in Nigeria where higher volatility decreases the contribution of the tourism industry to the national economy (48-55).

Webber in his study on analysing the long-run demand for Australian outbound leisure tourism for nine major tourism destinations shows that for a half of the countries under investigation,

exchange rate volatility is a significant factor of long-run demand for tourism (398–405). Further, he highlights that since volatility in the exchange rate provides an indication on variations in relative price it influences the choice of travel destination. In contrast, Yap through his research claims that "a sudden appreciation of the Australian dollar will not have long term negative impact on tourist flows to Australia as tourist's memories of such shocks could lessen in the long run" (111-132).

This bidirectional relationship observed between number of tourists coming from a particular destination to a particular origin and bilateral exchange rate volatility is further investigated by Chang and McAleer in their research that focuses on investigating the impact of volatility in exchange rate on tourist arrivals to Taiwan from the world, USA and Japan, where they reveal the that impact of price and price volatility vary (397-419). Moreover, they claim that even though the exchange rate may have the expected negative impact on tourist arrivals, the effect of exchange rate volatility on tourist arrivals can have a positive or negative effect depending on the destination and origin pair considered.

Gallego, et al. in their research on exchange rate regimes and tourism find that an approximately 6.3% improvement in tourism is witnessed through the introduction of euro as a common currency. Further, they argue that intermediate exchange rate regimes such as managed floating or a currency peg also have an ability to promote tourism to a certain extent. Hence, they conclude that lesser the flexibility in exchange rate, higher the positive impact in promoting tourism. Ledesma-Rodríguez et al. (qtd. in De vita 223-236) also evaluate this trend for a sample of Organization for Economic Co-operation and Development (OECD) countries and concluded the same. Thompson and Thompson through their research further confirm this where they reveal that the introduction of euro increased tourist revenue by approximately 18% in Greece (773-778). De vita in his study employing 27 OECD and non-OECD countries to identify the long-run impact of exchange rate regimes on international tourism flows reveals that there is a significant impact from multiple exchange rate regimes on tourism inflows to a particular country and emphasised that international tourists can be attracted through sustaining a stable exchange rate (223-236).

2.3 Measuring exchange rate volatility

Measuring the extent of the "exchange rate volatility" has become a concern for policymakers and academics mainly with the end of the Bretton Woods Agreement (Epaphra 121-143) where in 1973, foreign governments let currencies float (Investopedia, 2003). One of the main debates in empirical literature on this topic is whether to use real or nominal exchange rate in measuring volatility. Earlier studies have used nominal exchange rates (Thursby and Thursby, 488-495), while more recent studies have used real exchange rates (Peace, et al. 48-55; Agiomirgianakisa, et al. "Iceland" 25-34; Vieira and MacDonald, 203-221) stating that it is the most appropriate measure. However, some researchers through their studies showed that there

is no substantial difference in using real or nominal exchange rate (Choudhry 51–71; McKenzie and Brooks 73-87)

Empirical literature proposes a number of methods to measure volatility. Agiomirgianakis et al. ("Iceland" 25-34, "UK" 1-12, "Turkey" 700-725) and Chowdhury (700-706) have used standard deviation of the moving average of the logarithm of the real effective exchange rate to estimate exchange rate volatility (Agiomirgianakis et al. "Iceland" 25-34, "UK" 1-12, "Turkey" 700-725; Chowdhury 700-706). However, the main pit fall in this estimate is that it is unable to capture the impact of peak values of the exchange rate. Agiomirgianakis et al. and Peace et al. overcame this issue by using a separate variable to account for high and low peak values of the real effective exchange rate (Agiomirgianakis et al. "Iceland" 25-34, "UK" 1-12, "Turkey" 700-725; Peace et al. 48-55). Some measures, however, less frequently used in literature include the random walk model (Webber, 398–405), averages of absolute changes (Song and Witt, 2011), standard deviation of the exchange rate series and deviation from the trend (Ekanayake and Chatrna 51-67).

Choudhry points out that above mentioned volatility estimation methods disregard underlying stochastic process from which the exchange rates are created (51–71). Thus, many researchers (Al-Najjar 157-162; Bala and Asemota 89-116;Choudhry 51–71; Ekanayake and Chatrna 51-67; Epaphra 121-143; Murari 22- 37; Pelinescu, 543 – 549; Pilbeam and Langeland, 127–142; Thorlie, et al., 1206-1214; Vieira and MacDonald, 203-221) have used conditional variance of the first difference of the log of the exchange rate as volatility where conditional variance is estimated by the Autoregressive Conditional Heteroskedasticity (ARCH) model introduced by Engleand its extension, Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model which was developed to overcome the limitations of the ARCH by allowing longer memory and flexible lag structure, which was proposed independently by Bollerslev and Taylor to model volatility(Engle 987-1007; Bollerseley 307 327). These models account for dynamic conditional variance (Epaphra 121-143) as it allows conditional variance to change over time as a function of past errors as opposed to constant variance assumption in conventional time series models (Al-Najjar 155-162). In addition, these models have become popular among researchers as they enable them to measure the variance of a series at a specific point in time (Enders, *Applied Econometric Time Series 2*).

These models also have an ability to capture inherent characteristics of volatility clustering and leverage effects in financial time series like exchange rate series (Choudhry 51–71; Epaphra 121-143; Thorlie, et al., 1206-1214). Volatility clustering is basically accumulation or gathering of information (Engel and West, 2005). It is described as the tendency of high positive or negative changes in asset prices to be followed by relatively high changes whereas small changes of either sign are expected to be followed by relatively small changes (Brooks 527-545). It means that the current level of volatility is positively correlated with the volatility observed in immediately preceding periods (Epaphra 121-143).

Empirical literature frequently observes that the depreciation in the exchange rate is followed by higher volatility (Abdalla 216-229; Murari 22- 37; Syarifuddin, et al., 35 - 54; Epaphra 121-143) which is referred as the leverage effect. In other words, price movement is negatively correlated with the volatility (Campbell and Kyle 1-34; Murari 22- 37). Leverage effect implies that conditional variance of the exchange rate return series can respond asymmetrically to positive or negative values of the exchange rate return series. However, GARCH models assume symmetric responses to positive or negative shocks (Epaphra 121-143). Thus, to overcome this limitation many asymmetric GARCH models have been developed as extensions of the simple GARCH model (Bala and Asemota 89-116). Among these models, the "Exponential Generalized Autoregressive Conditional Heteroskedasticity" (EGARCH) model (Nelson 347–370) and "GJR-GARCH" (Glosten et al. 1779-1801) are more popular (qtd. in Pilbeam and Langeland 127–142). Both EGARCH and GJR-GARCH models can extract the leverage effect but GJR-GARCH does not estimate log returns. Therefore, non-negative constraints should be imposed. These non-linear extensions of the GARCH model use non-normal distributions (Student-t, Generalized Error Distribution and Skewed Student-t) since GARCH models sometime fail to capture the property of fat-tail, excess skewness and kurtosis of financial data (Thorlie et al. 1206-1214; Lahmiri 387–395).

2.4 Research relating to exchange rate volatility and tourism sector in Sri Lankan context

Ekanayake and Chatrna conducted an empirical investigation on the effect of exchange rate volatility on Sri Lankan exports (51-67). In their study, they measured volatility in the real effective exchange rate using the conditional variance derived from the GARCH (1,1) model. The study reveals that depending on the type of export goods, the impact of exchange rate volatility differs, and they were unable to observe a firm connection among exchange rate volatility and Sri Lankan exports. Jayasekara estimate exchange rate volatility by relative change in real exchange rate in his study that focused on finding the effect of exchange rate volatility on foreign direct investments (75-96). This research revealed that stability in exchange rate will attract foreign direct investment into Sri Lanka.

Konarasinghe forecasts tourist arrivals to Sri Lanka during the post-war period based on monthly tourist arrival data using the Holt's Winter's three parameter model (57-63). However, it is accurate only for short term forecasting, thus, suggesting that using decomposition models such as ARCH, GRACH would be better for long term forecasts. Welgamage developed an econometric model based on the Cobb-Douglas function in order to analyse the relationship between foreign exchange earnings, tourist spending, tourist prices, tourist flows and employment in the tourism sector (90-101). This study reveals that foreign exchange earnings are significantly influenced by these variables. Moreover, foreign exchange earnings had a significant positive relationship with tourist spending, tourist flows and employment in the tourism sector, while tourist prices indicated a negative impact. Fernando et al. identify a significant seasonality in tourist flows to Sri Lanka with a large variability in monthly tourist

arrivals to Sri Lanka (575–586). They argue that war related incidents are negatively related to tourist flows where tourist arrivals were reduced by 5.2% in comparison to a period in which peace prevailed. Lelwala and Gunaratne modelled tourism demand for Sri Lanka from the United Kingdom (UK) and find that the income of UK is the most important demand determinant (50-59). Selvanathan) in his research on "the effect of war and other factors on Sri Lankan tourism" concludes that there is a positive impact on tourism from the government's free trade policy and a negative influence on the tourism sector from war related incidents (35–38).

3. Methodology

3.1 Model specification

The main objective of this research is to evaluate the effect of exchange rate volatility on tourist flows into Sri Lanka. Earlier research studies in this area have modified the export demand function of Glodstein and Khan by incorporating an estimate of exchange rate volatility and including dummy variables to account for seasonal effects and special events (qtd. in Agiomirgianakis et al. "Iceland" 25-34, "UK" 1-12, "Turkey" 700-725; Arize , et al. 10-17; Ekanayake and Chatrna 51-67; Mwangi, et al. 1-12; Onafowora and Owoye 1547-1556; Serenis and Tsounis, 71-107). Thus, based on the existing empirical literature, this present study developed a standard long run tourism demand function for Sri Lanka as specified in the equation 1 below.

$$lnX_t = \beta_0 + \beta_1 lnI_t + \beta_2 lnRP_t + \beta_3 lnV_t + \beta_4 M_{1t} + \beta_5 M_{2t} + \beta_6 M_{3t} + \beta_7 M_{4t} + \beta_8 M_{5t} + \beta_9 M_{6t} + \beta_{10} M_{7t} + \beta_{11} M_{8t} + \beta_{12} M_{9t} + \beta_{13} M_{10t} + \beta_{14} M_{11t} + \beta_{15} P_t + \varepsilon_t \quad (1)$$

Where t is the time dimension, ln indicates that the variables are converted to their natural logarithm values, X_t is the number of tourist arrivals at time t (a proxy for tourist demand), $I_t$is the income at tourist origin at time t proxied by industrial production indices of origin countries, RP_t is the relative price, which is proxied by a ratio of Consumer Price Index (CPI) between destination country and origin country adjusted to exchange rates and V_t an estimate of exchange rate volatility at time t. A separate exchange rate variable is not included to the above tourist demand model because relative price is standardized using a bilateral exchange rate and therefore the inclusion of an additional exchange rate variable will result in problems of multicollinearity and model bias, as explained in Section 2.1.3 of the literature review. The Loglinear transformation is adopted to minimise heteroskedasticity and it is the most appropriate and frequently used functional form in previous studies.

M_{1t} to M_{11t} are seasonal dummies to account for monthly seasonality, P_t is a dummy variable to represent the end of civil war in Sri Lanka with a value of 1 representing the period after the end of civil war (sample period of 2009 June to 2016 October) and 0 to represent the period of civil war in the sample (1990 January to 2009 May) whereas ε_t is the error term. The inclusion of the dummy variable P_t is further confirmed by Figure 1, where an exponential growth is witnessed after 2009 May.

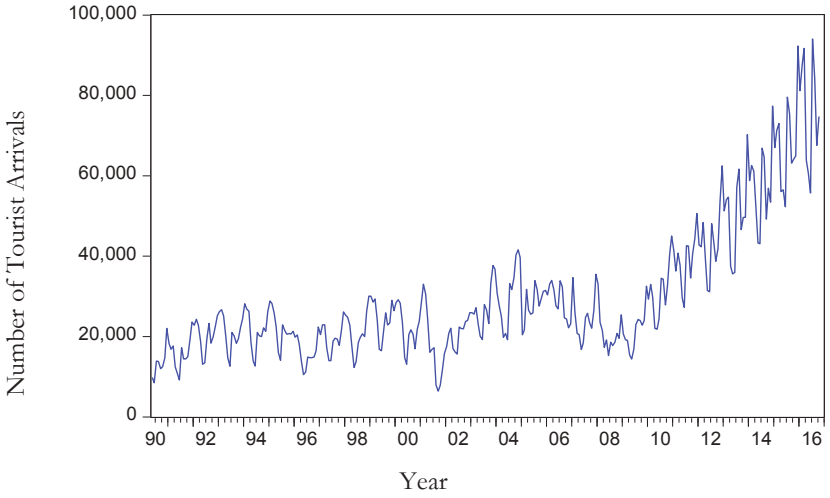
3.2 Data sources and variable definitions

This research study employed secondary time series data with monthly frequency starting from January of 1990 to October 2016. Accordingly, this study covers a period of approximately 27 years with 322 monthly observations for each variable considered in this research.

Tourist arrivals are used as the proxy for tourism demand since it is the most frequently used proxy in the literature. Moreover, tourism expenditure, which is a better proxy as explained in Section 2.1.1 of the literature review is not available in monthly frequency with the country disaggregation. The analysis focus on tourist arrivals from seven major country origins; namely, United Kingdom, India, Germany France, Australia, Japan and Netherland. These were selected based on an annual average rank for the period under investigation. A rank was given for each country for each year based on the annual tourist arrivals to Sri Lanka from that particular country. Then an average annual rank was computed, which is the average of ranks for the 27 years from 1990 to 2016. Subsequently, the aforementioned top seven countries (namely United Kingdom, India, Germany, France, Australia, Japan and Netherland) were selected based on this average rank so that it covers more than 50% of the tourist arrivals to Sri Lanka during the investigation period. The trend in tourist arrivals from these selected countries is given in Figure 1, below. It clearly indicates that there is an exponential growth after 2009 May with the end of the civil war. This further validates the inclusion of a dummy variable to incorporate this structural break into the tourism demand model specified under Section 3.1, above.

Historical data on monthly tourist arrivals to Sri Lanka with country disaggregation were not freely available in electronic format. Thus, the data was officially requested from the Sri Lankan Tourism Development Authority (SLTDA) and extracted from various issues of SLTDA's Annual Statistical reports, which were available at their library.

Figure 1: Tourist Arrivals to Sri Lanka from United Kingdom, India, Germany France, Australia, Japan and Netherland



Source: Author's calculations based on data from IMF, IFS data base and SLTDA using Eviews® statistical software

In this study, the Industrial production Index (IPI) is used as the proxy for foreign income since personal disposal income or per capita GDP or GNI is not available with monthly frequency. As better explained in Section 2.1.1 of the literature review, IPI is advantageous in this scenario since it deals with monthly data. Thus, following Ekanayake and Chatrna, weighted average of IPIs of the selected seven major tourist origins were computed as follows,

$$I_t = \sum_{j=1}^{7} W_{jt} I_{jt} \qquad (2)$$

Where I_t is the real foreign income at time t, W_{jt} is a weight representing the share of tourist arrivals from jth country to Sri Lanka at time t from total tourist arrivals from the seven major tourist origin countries at time t, and I_{jt} is the IPI of the jth country at time t (Ekanayake and Chatrna 51-67). The seven major tourist origin countries are United Kingdom, India, Germany, France, Australia, Japan and Netherland. The respective IPI's (with the base year 2010=100) of these selected countries were extracted from the International Monetary Fund (IMF)'s International Financial Statistics (IFS) database. However, in Australia, the IPI is calculated based on quarterly frequency, hence, the quadratic match average technique of low

to high frequency conversion in Eviews® was used to convert these quarterly index values into monthly indices.

As explained in Section 2.1.2 of the literature review, the price factor includes two main components, namely cost of transport to and from destination and cost of living for tourist at destination. In this study only the cost of living component is taken into consideration due to the complexity in deriving a proxy for cost of transportation and lack of disaggregated data available to construct such estimates which is better explained in literature review. Literature reveals that the most appropriate proxy for tourist cost at destination is the tourism price index (Dwyer and Forsyth 751-777). A separate tourism price index is computed for Sri Lanka by the SLTDA, covering the tourist expenditure on accommodation, food and transport (Sri Lanka Tourism Development Authority). However, it is only computed on an annual basis with a considerable time lag. Further, this index was not available for some countries in the selected sample. In addition, since each national statistical institute use customised definitions it is practically difficult to arrive at an aggregate index. Thus, due to these practical issues and in order to maintain cross country homogeneity CPIs were used as the proxy to compute a measure for relative prices. Accordingly, this study also uses the most frequently used proxy for relative prices as better explained in Section 2.1.2 of the literature review. Following the concept of Gonzalez and Moral and Dogru et al. the relative price was computed as follows with a slight modification to include a weight to combine price relatives of the seven origin countries (Gonzalez and Moral 233-251; Dogru et al. 47-55):

$$RP_t = \sum_{j=1}^{7} W_{jt} \frac{CPI_{SL,t}}{CPI_{jt} ER_{jt}} \qquad (3)$$

Where PR_t is the relative price at time t, W_{jt} is a weight representing the share of tourist arrivals from jth country to Sri Lanka at time t from total tourist arrivals from the seven major tourist origin counties at time t, and monthly CPI_{jt} is the monthly CPI of the jth country at time t, $CPI_{SL,t}$ is the monthly CPI of Sri Lanka at time t, and ER_{jt} is the monthly average exchange rate, rupees per unit of currency in jth country at time t. The seven major tourist origin counties are United Kingdom, India, Germany, France, Australia, Japan and Netherland. The respective CPI's (with the base year 2010=100) of these selected countries were extracted from IMF's IFS database. However, in Australia, CPI is calculated based on quarterly frequency, hence, the quadratic match average technique of low to high frequency conversion in Eviews® was used to convert these quarterly values into monthly indices. The respective domestic currency exchange rate per USD of Sri Lanka and other countries considered in the sample were extracted from the IMF's IFS database and these were used to arrive at rupee rate per unit of currency in j^{th} country since rupees per unit of currency in j^{th} country was not available in the IMF statistics database. Germany, France and Netherland

joined the European Union on 1st January 1999. Therefore, their domestic currency exchange rates were not available after this date. To overcome this issue from 1st January 1999, the Euro per USD exchange rate was considered and multiplied by respective irrevocable conversion rates for the euro, fixed by the Ministers of Finance of the countries making up the euro area, to create a measure for domestic currency exchange rate. The respective irrevocable conversion rates for Germany, France and Netherland were obtained through European commission's official website (European Commission). This conversion was necessary to maintain the consistency of the exchange rate series of these countries across the time period considered for this research.

Real effective Exchange rate (REER) was not available for Sri Lanka in the IMF, IFS database. The Central Bank of Sri Lanka (CBSL) published a REER (with latest base year=2010) with weights based on the proportion of bilateral trade to Sri Lanka's total foreign trade in 2010, which can be used as an indicator for the country's external competitiveness (CBSL *Annual Report 2010*). However, the figures are only available from 2003. Further, as stated by Dwyer and Forsyth this is not an accurate measure of competitiveness for the tourism industry because tourism trade patterns are different from the overall trade patterns (751-777). Thus, following Sekkat and Varoudakis, and Ekanayake and Chatrna, the tourism weighted real exchange rate, RER_t , was constructed as,

$$RER_t = \sum_{j=1}^{7} W_{jt} \frac{ER_{jt}\, CPI_{jt}}{CPI_{SL,t}} \qquad (4)$$

Where RER_t is the real effective exchange rate at time t, W_{jt} , ER_{jt}, CPI_{jt}, and $CPI_{SL,t}$ are the same as defined above. A decrease in RER_t indicates an appreciation in exchange rate while an increase indicates a depreciation (Sekkat and Varoudakis 237–253; Ekanayake and Chatrna 51-67).

3.3 Measuring exchange rate volatility

As explained in detail in Section 2.3 of the literature review, this research uses conditional variance of the first difference of the log of the real effective exchange rate(R_t) as volatility. First difference of the log of the real effective exchange rate(R_t) is also termed as the exchange rate return series and is computed as;

$$R_t = ln(RER_t) - \ln(RER_{t-1}) \qquad (5)$$

Where RER_t is the real effective exchange rate at time t. The conditional variance of R_t is estimated through an ARCH-type model. This method was selected due to its ability to capture inherent features such as volatility clustering, leverage effect, excess kurtosis, skewness and fat

tail properties observed in financial series as better explained in Section 2.3 of the literature review.

Among the ARCH type models presented in the literature, the EGARCH (Nelson 347–370) model is selected to derive the required conditional variance in this research, since conditional variance will be positive even if the parameters are negative, as it measures log returns. Thus, non-negative constraints need not be imposed artificially (Brooks 527-545) and it has an ability to capture the asymmetry in volatility clusters, which is the leverage effect (Pelinescu 543 – 549). The EGARCH (1, 1) model of Nelson which is estimated in this research based on AR (3) model for mean equation is defined as follows (qtd. in Brooks 527-545),

$$\ln(\sigma^2{}_t) = \omega + \lambda \ln(\sigma^2{}_{t-1}) + \theta \frac{u_{t-1}}{\sqrt{\sigma^2{}_{t-1}}} + \gamma \left[\frac{|u_{t-1}|}{\sqrt{\sigma^2{}_{t-1}}} - \sqrt{\frac{2}{\pi}} \right] \qquad (6)$$

$$R_t = c + \alpha_1 R_{t-1} + \alpha_2 R_{t-2} + \alpha_3 R_{t-3} + u_{t-1} \qquad (7)$$

Where 6 is the conditional variance equation and 7 is the mean equation, $\sigma^2{}_t$ is the one period ahead conditional variance, which is estimated from past information. This estimated conditional volatility is used as the measure of volatility in this research. ω, λ, θ and γ are parameters to be estimated. There are no restrictions for ω, θ and γ but λ must be positive and less than one to maintain stationarity. θ measures the leverage effect or asymmetry in volatility clusters. If θ is negative and significant then it implies that the leverage effect is present (Epaphra 121-143). It implies that positive shocks create less volatility than negative shocks of the same magnitude (Brooks 527-545; Ali 57-73). λ measures the persistence of conditional volatility, where large and significant estimate for the parameter implies that volatility takes a long time to reduce after a shock in the system (Alexander). γ represents the GARCH effect or the symmetric effect (Epaphra 121-143).

As better explained by Lahmiri the choice of distribution assumption also impacts the performance of the EGARCH model (387–395). Thus, the Generalized Error Distribution is selected because of its capability in capturing excess kurtosis in time series (Nelson, 347–370; Lopez 87–109; Marcucci 1-55; Lahmiri, 387–395).

3.4 Estimation method

Stationarity of the variables was assessed using both the Phillips-Perron (PP) test (Phillips and Perron 335–346) and Augmented Dickey-Fuller (ADF) test (Dickey and Fuller 427-431) to corroborate the robustness of the tests and to ensure the inference on stationarity does not

depend on the selection of the test. Engle and Granger and Johansen and Juselius have proposed methods for assessing the existence of cointegration or long run equilibrium relationship among the variables (Engle and Granger 251-276; Johansen and Juselius 169-210). However, Engle and Granger's method has a limitation since it only assumes the existence of one cointegrated relationship (251-276). Therefore, the method proposed by Johansen and Juselius is used to evaluate the existence of cointegration and the number of cointegrated equations (169-210).

If the variables are non-stationary, the common remedy is to make them stationary by using the first difference of the variables. However, when the association among variables are vital, such a method is not suitable as pure first differenced models have no long run solution. This problem could be rectified by using an error correction or equilibrium correction model, which uses a combination of first differenced and lagged levels of cointegrated variables (Brooks 527-545).

The Engle- Granger representation theorem states that if the cointegrated relationship exists among a set of variables that are not stationary at level then it infers that a short run error correction relationship exists among them (251-276). Enders states that if long run elasticities exist, then it is rational to evaluate how short run behavior will respond to long run elasticities (*Applied Econometric Time Series* 3).

According to Engle and Granger deviated actual tourist arrivals are expected to return to its long run equilibrium (251-276). The short run relationship of this research can be denoted through an error correction model, as follows;

$$\Delta ln\, X_t = \alpha_0 + \alpha_1 EC_{t-1} + \sum_{l=1}^{m} \beta_i\, \Delta lnX_{t-i} + \sum_{l=0}^{m} \eta_l\, \Delta lnI_{t-1} + \sum_{l=0}^{m} \delta_l\, \Delta lnRP_{t-1} + \sum_{l=0}^{m} \varphi_l\, \Delta lnV_{t-1} + \omega_t \quad (8)$$

The first difference of tourist arrivals is a function of lagged tourist arrivals, current and lagged values of the independent variable and the lagged value of long run disturbance term (EC_{t-1}) (i.e., the residuals generated from the long run model given by the equation 1). According to Engle and Granger coefficient of the long run disturbance term reflects the short run adjustment and indicates the speed of adjustment towards long run equilibrium state where a high coefficient implies a rapid adjustment (251-276). Moreover, it measures the proportion of the previous period's equilibrium error that is corrected for. Whereas β_i's denotes the short run relationship between changes in independent and dependent variables.

3.5 Model Validity

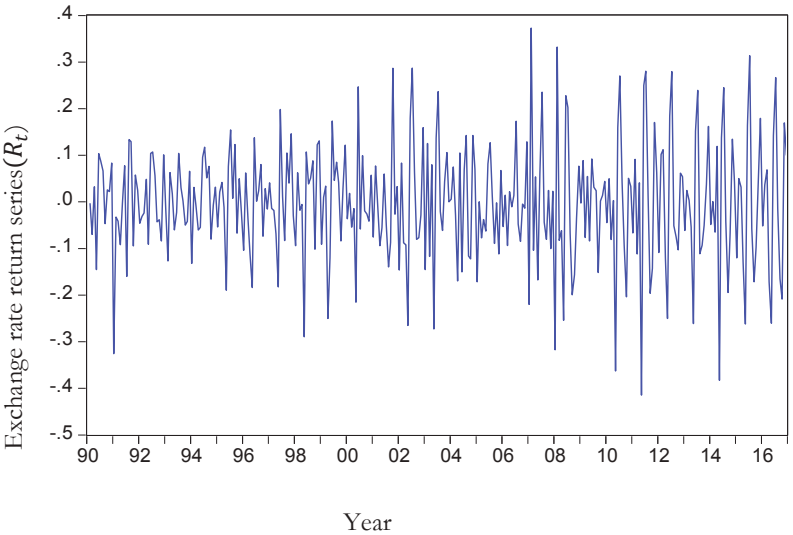
Model diagnostic was performed in order to evaluate the adequacy of the fitted models. Goodness of the fit of the model is assessed based on residuals (Epaphra 121-143). The residuals are assumed to be independently and identically distributed following a normal distribution (Gourieroux and Jasiak).

4. Analysis and discussion of the findings

4.1 Measuring volatility in the real effective exchange rate

As explained in detail in the Section 3.3 of the Methodology, this research uses conditional variance of the first difference (or change) of the log of the real effective exchange rate(R_t) as volatility. The first difference (or change) of the log of the real effective exchange rate(R_t) is hereafter referred to as exchange rate return series.

Figure 2: Exchange rate return series(R_t)



Source: Author's calculations based on data from IMF, IFS data base and SLTDA using Eviews® statistical software

Figure 2 illustrates that volatility occurs in clusters and hence provides evidence of time-varying volatility in exchange rate return series. This is referred to as the presence of the ARCH/GARCH effect and further validates the use of an ARCH type model. The ADF test was performed to identify unit roots in return series. The results of the test are presented in Table 1. The test rejects the null hypothesis of unit roots in the series and confirms that the exchange rate return series is stationary. Since the series is stationary the best fitting mean equation is identified through applying Autoregressive Moving Average (ARMA) to select the best process to model the conditional mean, which was identified as AR (3) process.

Table 1: Augmented Dickey Fuller test

H0: There exists a Unit Root (i.e. the process is not stationary) H1: No Unit Root exists (i.e. the process is stationary)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.156122	0.0000

*MacKinnon (601-618) one-sided p-values.

Source: Author's calculations based on data from IMF, IFS data base and SLTDA using Eviews® statistical software.

In order to obtain the conditional variance of the exchange rate return series(R_t), as clearly explained in Section 3.3 of the Methodology, the EGARCH (1,1) model is fitted based on AR(3) mean equation and equations 6 and 7 are estimated for the period from February 1990 to December 2016, with Generalized error distribution assumption using Eviews® statistical software. Table 2 below shows the results of the estimated equations.

Table 2: Estimation of conditional variance of the exchange rate return series(R_t) as a EGARCH (1,1) process

$$R_t = 0.001898 - 0.340690R_{t-1} - 0.315027R_{t-2} - 0.331853R_{t-3} + u_{t-1}$$

(0.7418) (0.0000)*** (0.0000)*** (0.0000)*

$$\ln(\sigma^2{}_t) = -2.218891 + 0.458877\ln(\sigma^2{}_{t-1}) - 0.369409\frac{u_{t-1}}{\sqrt{\sigma^2{}_{t-1}}} - 0.272486\left[\frac{|u_{t-1}|}{\sqrt{\sigma^2{}_{t-1}}} - \sqrt{\frac{2}{\pi}}\right]$$

(0.0078)*** (0.0164)** (0.0004)*** (0.0650)*

$R^2 = 0.21$ Durbin Watson =1.91 F-Statistic= 10.06 (0.0000)**

Note: The figures in parentheses are p-values; ***, ** and * indicate the statistical significance at the 1% , 5% and 10% level, respectively.

Source: Author's calculations based on data from IMF,IFS data base and SLTDA using Eviews® statistical software.

As explained clearly in Section 3.3 of the Methodology, λ should be positive and less than one to maintain stationarity. Accordingly, it can be observed from Table 4.1 that λ (=0.458877) is positive, significant at 5% and less than one, indicating that the estimated EGARCH model is stationary. In addition, the value is not large and it is significant, which means that the persistence of conditional volatility is moderate. In other words, volatility takes only an average time to reduce after a crisis in the market.

θ (= -0.369409) is negative and significant even at 1%, implying that the leverage effect is present. This reveals that negative shocks imply a higher next period volatility than positive shocks of the same sign. This is in line with the results of previous studies (Abdalla 216-229; Murari 22- 37; Syarifuddin, et al., 35 - 54; Epaphra 121-143), which revealed that the depreciation in the exchange rate is followed by higher volatility. γ (=0.0650) which represents the GARCH effect or the symmetric effect is significant only at 10%.

The goodness of the fit of the model is assessed through residual diagnostic tests, as explained in Section 3.5 of the Methodology. Durbin Watson statistic (=1.91) is close to 2, indicating no serial correlation among residuals. Serial correlation in residuals are further tested using autocorrelation (ACF) and partial autocorrelation (PACF) functions of the residuals, together with the Ljung-Box Q-statistics (Q-Stat) for higher order serial correlation. The results of these tests are given in Table 3.

Table 3: Serial Correlation Test

Lag	ACF	PACF	Q-Stat	P-value
1	0.057	0.057	1.0668	0.302
2	-0.102	-0.105	4.4106	0.110
3	-0.076	-0.064	6.2662	0.099
4	-0.079	-0.083	8.3014	0.081
5	-0.060	-0.068	9.4932	0.091
6	-0.081	-0.100	11.662	0.070
7	-0.014	-0.032	11.723	0.110
8	-0.068	-0.107	13.267	0.103

Source: Author's calculations based on data from IMF, IFS data base and SLTDA using Eviews® statistical software.

It is evident from Table 3 that there is no serial correlation in the model since none of the lags are found to be significant at a 5 % level to reject the null hypothesis of no serial correlation in residuals, confirming the adequacy of the fitted model. Further, Table 4 reveals that the ARCH-LM test doesn't reject the null hypothesis of no ARCH effects in the residuals, thus confirming that the conditional heteroskedasticity existed in the exchange rate return series is successfully modelled and no ARCH effect is left in the residual. This further confirms the adequacy of the fitted model. Therefore, predicted values of the conditional variance from the fitted EGARCH (1, 1) model were taken as the estimate of volatility of the real effective exchange rate, which is used in the tourism demand model of this research.

Table 4: Heteroskedasticity Test: ARCH-LM Test

F-Statistic	Prob. F (1,317)
0.473020	0.4921

Source: Author's calculations based on data from IMF, IFS data base and SLTDA using Eviews® statistical software.

4.2 Stationarity of the variables

To check for stationarity, the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller 427-431) and Phillips-Perron (PP) test (Phillips and Perron, 335–346) were applied to each variable at the level and the first difference. The null hypothesis of these unit root tests is that the series has a unit root or in other words the series under consideration is non-stationary, while the alternative hypothesis is that the time series considered is stationary. The results of these Unit root tests are given in Table 5.

Table 5: Unit Root (ADF and PP) Tests Results

H0: There exists a Unit Root (i.e. the process is not stationary) H1: No Unit Root exists (i.e. the process is stationary)

Variable	P-Value at Level		P-Value First Difference		Order of Integration I(d)
	ADF	PP	ADF	PP	
lnX	0.9584	0.9218	0.0000*	0.0000*	I(1)
lnI	0.9246	0.9693	0.0001*	0.0001*	I(1)
lnRP	0.2507	0.4073	0.0000*	0.0000*	I(1)
lnV	0.6713	0.5467	0.0000*	0.0001*	I(1)

*The null hypothesis is rejected since the P-value is less than 5% significant level

Source: Author's calculations based on data from IMF, IFS data base and SLTDA using Eviews® statistical software

It is evident from Table 5 that all the variables lnX, lnI, lnRP and lnV have unit roots in the level (i.e., Not stationary) under a 5% significant level. However, when unit root tests are performed on the first differences of these variables, the tests reveal that first differenced series are stationary. Hence, it can be concluded that all the variables are integrated of order one.

4.3 Cointegration analysis

Section 4.2 reveals that all the variables are integrated of order one. Therefore, the method proposed by Johansen and Juselius is used to evaluate the existence of cointegration and the number of cointegrated equations (169-210).

The result of the Johansen and Juselius cointegration test is given in Table 6 and it reveals that the null hypothesis of no cointegation is rejected at 5 % level of significance. Both Trace and Maximum Eigen value cointegration tests denote that there exists one significant cointegrating vector in the system. Moreover, this suggests that there is a unique long run equilibrium relationship among the variables. Therefore, Engle and Granger's two step method is used to estimate the error correction model since there is only one cointegated equation.

Table 6: Johansen's Test for Cointegration

H_0: No. of Cointegration equations	Trace		Maximum Eigen Value	
	Test Statistic	p-value***	Test Statistic	p-value***
None*	68.74480	0.0002	41.37394	0.0005
At most 1**	27.37087	0.0929	20.32274	0.0646
At most 2	7.048129	0.5720	6.706073	0.5245
At most 3	0.342056	0.5586	0.342056	0.5586

* Existence of at least one cointegrating vector (i.e. reject the null hypothesis at 5% significance)
** Existence of maximum of one cointegrating vector (i.e. do not reject of null hypothesis at 5% significance)
***MacKinnon-Haug-Michelis (1999) p-values

Source: Author's calculations based on data from IMF,IFS data base and SLTDA using Eviews® statistical software

4.4 Estimating long run Tourism Demand Model

The first step in the Engle and Granger method is the estimation of the long run relationship. The long run tourism demand model which is developed following empirical literature is specified in equation 1 in the Section 3.1 of the Methodology.

Therefore, as the first step, this model is estimated, and the residuals of this model are constructed, and it was tested for stationarity using Phillips-Perron (PP) unit root test (Brooks). The estimation of the tourism demand model yielded the following cointegrated equation.

$$\begin{aligned} lnX_t = {} & 3.969841 + 1.369242lnI_t + 0.155351lnRP_t - 0.091340lnV_t - 0.052469M_{1t} \\ & - 0.038151M_{2t} - 0.187027M_{3t} - 0.276691M_{4t} - 0.444709M_{5t} \\ & - 0.513591M_{6t} - 0.118102M_{7t} - 0.132471M_{8t} - 0.372547M_{9t} \\ & - 0.332925M_{10t} - 0.217922M_{11t} + 0.505152P_t \qquad (9) \end{aligned}$$

Where, ln represents natural logarithm, X_t is the number of tourist arrivals at time t (a proxy for tourist demand), I_t is the income at tourist origin at time t proxied by weighted industrial production indices of origin countries, RP_t is the relative price, which is proxied by weighted ratio of Consumer Price Index (CPI) between destination country and origin country adjusted to exchange rates and V_t an estimate of exchange rate volatility at time t given by EGARCH(1,1) process. M_{1t} to M_{11t} are seasonal dummies to account for monthly seasonality, P_t is a dummy variable to represent the end of civil war in Sri Lanka, with a value

of 1 representing the period after the end of civil war (sample period of 2009 June to 2016 October, i.e., the period where peace prevailed) and 0 to represent the period of civil war in the sample (1990 January to 2009 May).

As revealed by the coefficient of the exchange rate volatility variable (V_t) in equation 9, it has a negative long run effect on tourist arrivals with an elasticity of 0.091340 .This implies that exchange rate volatility tends to deter tourism demand in the long run since high volatility affects the choice of destination of risk averse tourist as well as tour operators. This negative relationship is in line with the findings of empirical literature (Peace et al. 48-55; Agiomirgianakisa et al. "Iceland" 25-34, "UK" 1-12, "Turkey" 700-725; Saayman and Saayman, 104-121). Moreover, it is expected that the number of risk averse tourists are significantly larger than risk lovers (Webber 398–405) and tour operators may shift locations to avoid exchange rate volatility, since the industry is dominated by package tourists (Agiomirgianakisa et al. "Iceland" 25-34).

Income at tourist origin (I_t) has a positive long run effect on tourist arrivals with an elasticity of 1.369242. This indicates that as income increases, tourists spend an increasing share of their income on foreign tours. This direction is in line with economic theory as well as empirical literature (Cheng167–181; Peng, et al., 611–633). Moreover, as income elasticity is greater than one, the tourism product of Sri Lanka can be considered as a luxury good.

The relative price RP_t variable is positive with an elasticity of 0.155351. This finding is in line with Agiomirgianakis et al. study (Agiomirgianakis et al. "UK" 1-12) but against standard economic theory that emphasises that rise in price level results in reduced demand for most of the goods and services. This does not mean that Sri Lankan Tourism is a Giffen good, but tourist visit Sri Lanka for the unique tourism product it offers. As highlighted by Crouch this may also be due to a strong income effect that outweighs the substitution effect ("Demand Elasticities" 117-136). Further, the proxy used for the relative price variable, which is the weighted ratio of CPIs between destination country and origin country adjusted to exchange assumes that domestic tourism at the origin country is a substitute for foreign travel to the destination country. This assumption may not be true for the seven origin countries considered in this research.

The peace dummy (P_t) that is incorporated in the tourism demand model to distinguish the period where peace prevailed has a positive long run effect on tourist arrivals. This emphasises that political stability is a necessity in order to boost tourism demand, which is reflected by the fact that the period where peace prevailed in Sri Lanka has a positive influence on the quantity of tourist flows to the country.

However, it should be noted at this stage that it is not possible to test the hypothesis regarding the cointegated relationship (Brooks).

The result of the Phillips-Perron (PP) unit root test on the residuals of the long run tourism demand model is given in Table 7 and it reveals that the residuals are stationary, confirming the existence of a cointegration among these variables. These residuals form the Error Correction term (EC) of the short run model.

Table 7: Unit Root test on the residuals

	Adj. t-Statistic	Prob.*
Phillips-Perron test statistic	-4.599101	0.0000

*MacKinnon (601-618) one-sided p-values.

Source: Author's calculations based on data from IMF, IFS data base and SLTDA using Eviews® statistical software

4.5 Error Correction Model

The short run dynamics of the tourism demand function is evaluated through estimating an error correction model, as suggested by Engle and Granger and applied frequently in empirical literature (Choudhry 51–71; Mwangi, et al. 1-12; Ekanayake and Chatrna 51-67). The error correction model for this research as specified in equation 8 following Henry's (qtd. in Ekanayake and Chatrna 51-67 and Choudhry 51–71) general to specific modelling strategy. Initially, it involves regressing the first difference of tourist arrivals on a constant term, one lag error correction term (EC_{t-1}) and zero to eight lags of first difference of each variable in equation 1. Then as stated by the general to specific method, final parsimonious specification was achieved by reducing the dimensions by eliminating insignificant coefficients. In this general to specific approach, statistical adequacy of the model and diagnostics tests are given priority with an examination of inference drawn from theory hold until a statistical adequate model is found (Brooks).

The results of the estimated error correction model are given in Table 8. Where ln represents natural logarithm, the symbol Δ is the first difference operator, X_t is the number of tourist arrivals, I_t is the income at tourist origin, RP_t is the relative price, V_t an estimate of exchange rate volatility and EC_{t-1} is the error correction term.

Table 8: Results of the error correction model

Variable	Coefficient	Standard error	P value
Constant	0.007313	0.008531	0.3920
EC_{t-1}	-0.124359**	0.031958	0.0001
ΔlnX_{t-5}	0.149074**	0.043622	0.0007
ΔlnI_{t-5}	0.288492**	0.133678	0.0317
$\Delta lnRP_t$	-0.735113**	0.051030	0.0000
ΔlnV_t	-0.069405**	0.019901	0.0006

*R2=0.45; F-statistic =49.4(0.00**); Durbin-Watson stat=2.12*
*** denotes significance at 5% level*

Source: Author's calculations based on data from IMF, IFS data base and SLTDA using Eviews® statistical software

The Table 8 indicates that, as theoretically predicted, the error correction term has the appropriate negative sign and it is statistically significant at a 5% level. Since the error correction term is significant it is implied that the Sri Lanka's tourism demand model adjusts to changes in the independent variables. This reconfirms the presence of a steady long run equilibrium relationship between the variables in the cointegrating equation. Further, this validates the use of the error correction mode and reconfirms that the variables are cointegrated. As revealed by the coefficient of the error correction term, only 12.44 per cent of the disequilibrium is eliminated in one month. These estimates of error correction model suggest that if there are no further shocks, the gap to revert back to equilibrium would be closed within approximately eight months. Thus, it reveals that adjustment takes a relatively long time. Moreover, adjustment of tourist arrivals to any change in the independent variables of the tourist demand model takes a long time to return to the equilibrium.

The coefficients of the lagged values of ΔlnI_t, $\Delta lnRP_t$ and ΔlnV_t are short run parameters, measuring the short run immediate impact of independent variables on the dependent variable ΔlnX_t .

The estimated coefficient of the first difference of exchange rate volatility (ΔlnV_t) which is the growth of volatility is significant and has the expected negative sign similar to the relationship observed in the long run model. This means that a unit change in the exchange rate volatility will impact the Sri Lankan tourism demand negatively. Further, the coefficient of the short run model is smaller than the coefficient of the long run model indicating that the

exchange rate volatility has a smaller effect on tourism demand in the short run when compared to the long run.

The estimated short run coefficient of the first difference of income at tourist origin(ΔlnI_{t-5}), which is the approximate growth of income, is significant and positive as in the long run but smaller in magnitude. This implies that Unit change in income at the tourist origin has a positive impact on Sri Lankan tourism demand, hence tourism is considered as a luxury good in the short run as well. However, the impact will come with a lag of five months.

It is interesting to note that the first difference of the price relative ($\Delta lnRP_t$) variable, which is the approximate rate of inflation, has a significant negative impact on the growth in tourist arrivals in the short run. This implies that tourists are price sensitive in the short run where a unit change in price will have negative impact on tourist arrivals to Sri Lanka. However, it is evident in the long run that the sensitivity had reduced partly due to higher income effects than the substitute effect or due to the fact that tourists consider the unique tourism product Sri Lanka offers rather than the associated price.

The coefficient of the lagged first difference of tourist arrivals (ΔlnX_{t-5}), which is the growth rate of tourist arrivals before five months has a significant positive impact on the current growth of the tourist arrivals. This can be interpreted as the impact of word of mouth recommendation or habit persistence (Witt and Witt 447–475). Habit persistence means once people have visited a specific country and if they like it they will tend to return since they know it's less risky than vising an unknown destination.

4.6 Model Validity

The coefficient of multiple determination (R2) of the fitted error correction model is 0.45(Refer Table 8). It denotes that 45% of the variance in the volume of tourist arrivals are predicted by the independent variables. This indicates that the explanatory power of the independent variables is moderate. F statistics is also significant even at a 1% level, indicating that the variation in the long run tourist arrivals can be attributable to changes in the independent variables. In addition, as explained in detail under Section 3.5, the model diagnostic based on residuals need to be carried out to evaluate the adequacy of the fitted error correction model.

The Durbin-Watson (DW) is 2.12 (Refer Table 8), inferring no serial correlation among residuals. In addition, correlograms and Q- statistics were also computed to assess the serial correlation and the results are presented in Table 9. It is evident from Table 9 that ACF and PACF values are closer to zero and Ljung-Box Q-statistics are insignificant at a 5% level, which indicates that the null hypothesis of no serial correlation among residuals is not rejected, which further confirms the results of the DW test.

Table 9: Serial Correlation Test for the residuals from the Error Correction model

Lag	ACF	PACF	Q-Stat	P-value
1	-0.065	-0.065	1.3274	0.249
2	0.019	0.015	1.4466	0.485
3	-0.097	-0.096	4.4539	0.216
4	-0.028	-0.041	4.7003	0.319
5	-0.033	-0.035	5.0413	0.411

Source: Author's calculations based on data from IMF, IFS data base and SLTDA using Eviews® statistical software

The Breusch-Pagan-Godfrey (BPG) Heteroskedasticity Test was performed to identify Heteroskedasticity in residuals. The test results are presented in Table 10 and results indicate that the null hypothesis of no Heteroskedasticity in residuals is not rejected at a 5% significance level. This implies that the residuals series of the fitted error correction model is homoscedastic. Thus, the fitted model fulfilled all diagnostic tests. Therefore, it can be concluded that the model is adequate to capture the variations of the considered variables. In other words, Sri Lanka's tourism demand can effectively be explained using the specified independent variables.

Table 10: Heteroskedasticity Tests: Breusch-Pagan-Godfrey (BPG)

F-Statistic	Prob. F(1,317)
0.863053	0.5062

Source: Author's calculations based on data from IMF, IFS data base and SLTDA using Eviews® statistical software

5. Concluding remarks and policy implications

The main objective of this study is to ascertain the effect of exchange rate volatility on tourist flows into Sri Lanka and its implications on tourism policy, with the secondary objectives of identifying the effect of income at origin (i.e. income elasticity) and effect of relative prices between destination and origin (i.e. Price elasticity) on tourism demand, which is measured

through tourist arrivals to Sri Lanka. The empirical research provides ambiguous conclusions regarding these relationships depending on the different country combinations. Thus, identifying the impact of these tourism demand determinants in the Sri Lankan context provides a foundation for destination development planning as well as to the development of customised marketing strategies.

The dynamic relationship between tourist arrivals, exchange rate volatility, income at origin and relative prices were assessed using the theory of cointegration and error correction representation, using monthly data from 1990 to 2016.

In this context, the real effective exchange rate volatility was measured by conditional variance of the estimated Exponential Generalized Autoregressive Conditional Hetroscedasticity (EGARCH (1,1)) model given by equations 6 and 7 since the ARCH effect existed in the data. Results reveal that in the Sri Lankan context volatility takes a moderate time to reduce after a crisis in the market. Further, as revealed by the significant and negative leverage effects the depreciation in exchange rate is followed by higher volatility in Sri Lankan context which is in line with the findings of empirical literature (Brooks 527-545; Ali 57-73). Then the study used the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller 427-431) and Phillips-Perron (PP) test (Phillips and Perron, 335–346) to each variable used in this study to test their long run stability or stationarity. The results revealed that all the variables have unit roots, thus, it is concluded that they are not stationary. The method introduced by Johansen and Juselius was used to identify whether these non-stationary variables are cointegrated which revealed that these are cointegrated with the unique long run equilibrium relationship of tourism demand model, as given in equation 1(Johansen and Juselius 169-210).

Finally, the error correction model given by equation 8 is estimated to detect the speed of adjustment to the long run equilibrium path with sudden shocks in the short run. The coefficient of the error correction term is negative and statistically significant with a value of 0.1244. This reconfirms the presence of a steady equilibrium long run association among the variables and the negative sign of the coefficient indicates that the correction or the rectification is towards the long run equilibrium. The adjustment of tourist arrivals to any variation in the independent variables of the tourist demand model takes a long time to return to equilibrium since based on the magnitude of the coefficient of the error correction term only 12.44 per cent of the disequilibrium is eliminated in one month and total adjustment will take approximately eight months. This implies that the market forces in tourism market do not restore equilibrium quickly.

The study concludes that the exchange rate volatility has a significant negative impact on tourist flows into Sri Lanka both in the short run as well as in the long run. A volatile exchange rate increases uncertainty and transaction costs. Moreover, economic, political and social instability is often reflected by a volatile exchange rate. Thus, this adversely impact the choice of destination of risk averse tourists as well as tour operators. Majority of the previous research

(Peace, et al. 48-55; Agiomirgianakisa, et al. "Iceland" 25-34, "UK" 1-12, "Turkey" 700-725; Aktaş and Özkan 493-499; Saayman and Saayman, 104-121; Webber, 398–405) have also identified this negative relationship, thus findings of this research are encouraging. Therefore, the findings suggests that policy makers should take necessary actions to maintain the stability and the competitiveness of the exchange rate. Thus, when designing trade policies due consideration should be given to the impact of these policies on exchange rate volatility as well as its competitiveness. However, this stabilization should not be achieved through high inflation (Goldfajn and Gupta 90-114). In addition, tourism policy makers should limit targeting tourist markets that are prone to economic, social and political instability that could result in volatile exchange rates, since it will impact tourist flows from those countries negatively. Hence, it will eventually increase uncertainty on the return on investment in marketing.

In line with economic theory as well as empirical literature, it was found that the Sri Lankan tourism product is a luxury good, thus having a high-income elasticity, which is related to an increase in purchasing power with increasing real income. This suggests that tourism policy makers should target countries with stable economic growth and high per capita income when designing promotional campaigns, which will ensure a stable tourism demand in the long run. Moreover, Peng et al. (611–633) through their research concluded that tourists who travel to Asia indicate the highest income elasticity, which further validate the results obtained through this research (Peng et al. 611–633).

This study reveals that the change in relative price, which is the approximate rate of inflation, has a significant negative impact on the growth in tourist arrivals in the short run. This implies tourists are price sensitive in the short run. However, in the long run the price sensitivity had reduced partly due to the higher income effect than the substitute effect or due to the fact that tourists consider the unique tourism product Sri Lanka offers rather than the associated price or as a combined effect. Therefore, policy makers should control tourism inflation in the short run by either introducing control mechanisms for prices charged from the tourist or improving productivity of the sector since price competitiveness is an influential factor for tourism demand in the short run. In addition, they can evaluate the pricing strategies of competitor countries to develop an effective pricing policy that will enhance competitiveness. However, in the long run price competitiveness will not matter. Hence, sufficient consideration should be given to developing the unique tourism products offered by the country to which tourist will be attracted irrespective of the prices charged. Therefore, policies should be developed to enhance the differentiation of the tourism product offered by Sri Lanka. In this regard, MICE (Meeting, Incentives, Conferences and Events) tourism, agro tourism, village and urban tourism, eco-tourism and medical tourism can be considered as high priority areas with low price elasticities of demand.

It was interesting to observe from this study that the growth rate of tourist arrivals before five months has a significant positive impact on the current growth of the tourist arrivals. As

revealed by the empirical literature this is known as habit persistency or/and word of mouth effect (Dogru et al. 47-55; Witt and Witt 447–475). When designing tourism policies these effects should be taken into consideration as these are significant in enhancing tourist inflows into Sri Lanka. For instance, habit persistence, in other words repeat tourism, can be enhanced through improving service quality and ensuring that the tourist will have positive experience in all aspects while staying in Sri Lanka. This will in fact create a positive perception about the tourism industry in Sri Lanka, which will enhance word of mouth recommendation. Therefore, apart from commercial advertising, policy makers should develop marketing strategies that focus on improving word of mouth recommendation.

The importance of favourable economic, political and social environment in enhancing the tourist demand for Sri Lankan is further reflected by the positive coefficient obtained for the peace dummy in the long run tourism demand model, which implies that the peaceful environment prevailed in the country after May 2009 had a positive impact on tourist arrivals to the country. Hence, policy makers should be cautious about this and should take necessary action to maintain a favourable economic, political and social environment in the country in order to encourage tourism.

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The Impact of Board Structure on Bank Performance: Evidence from European Banks

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Abstract

This study aims to investigate whether board characteristics of banking institutions affect their performance, using a panel data set comprising 45 banks and 270 bank-year observations in the European region over the period of 2010-2015. The study finds that there is a positive relationship between both the board size and the proportion of independent directors, and bank performance. Also, the study finds evidence that the gender diversity decreases bank performance. Interestingly, when it is tested for the presence of a non-linear relationship, the study finds an inverted U-shape relationship between both the board size and the proportion of independent directors, and the bank performance and a U-shape relationship between gender diversity and bank performance. The results show that the boards that are larger and not excessively independent are more effective in discharging their duties. Achieving the optimum mix of internal and external directors will result in the board becoming more efficient in their advisory and monitoring roles. Also, results shows that appointing female directors above a minimum threshold will improve bank performance, a finding that is consistent with the critical mass theory and supports the introduction of gender quotas as well. The findings of this study provide useful insights to policymakers in setting corporate governance regulations relating to board structures. The use of fixed effect estimation control for unobserved heterogeneity and the findings of the study are robust to alternative proxies of performance.

***Key Words**: Board Structure, Bank Performance, Corporate Governance*

***JEL Classification**: G21, G28, G30, G32, G38*

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1. Introduction

The governance structure of the financial institutions was largely criticised during the Global Financial Crisis (GFC) in 2008/09. It differs from the previous financial crises in which a large part of the blame was attributed to the loopholes in the risk management strategies and weak corporate governance structures within financial institutions. The introduction of the UK Combined Code of Corporate Governance in 2009, the Guidelines on Internal Governance issued by the European Banking Authority and the most recent introduction of the Green Paper of corporate governance in the United Kingdom (UK) show the importance given to corporate governance regulations by policy makers. In the governance structure, importance has been given to board characteristics such as board size, board composition and board diversity. Therefore, this study has focused on identifying the extent to which board characteristics affect bank performance by taking a sample of European banks during the post crisis period.

Failure of a bank costs an economy losses in trillions. All governments around the world conducted massive bailout packages during the crisis in which notable bailouts were the Royal Bank of Scotland and the Halifax Bank of Scotland in the United Kingdom. Similarly, European governments conducted massive bailouts that exceeded $ 10 trillion (Mishkin, 2016). A well-governed bank is critical to the efficient allocation of resources of an entire economy, due the role it plays in financial intermediation, the payments system, liquidity creation, and maturity and denomination transformation (Fama, 1985).

Bank governance via the board is the most effective way of achieving good governance. According to Caprio and Levine (2002), the board of directors (BOD) are an important source of good governance, because dispersed shareholders and debt holders cannot impose effective governance in banks. The BOD act as the link between the firm's management and the other stakeholders and this is of utmost importance, as banks operate in highly regulated and complex business environments. Also, it is more relevant in banks rather than in nonbanks, since the fiduciary responsibility of banks extend well beyond the shareholders to depositors and regulators as well (Macey and O'Hara, 2003). The GFC in 2008 provides the opportunity to study how better-governed banks performed during the crisis.

In the post-crisis period, the Basel Committee on Banking Supervision in its consultative document "Corporate Governance Principles for Banks" (2015) has identified the importance of the BOD in achieving effective corporate governance. Moreover, the second pillar of the Basel II "Supervisory Review Process" identifies the board as an essential part of risk management. In the USA, the "Dodd-Frank Wall Street Reform and Consumer Protection Act" enacted after the financial crisis includes provisions related to corporate governance. In the UK, the Walker Review, in 2010, on the financial services sector, gave rise to the UK Corporate Governance Code (latest amendment in April 2016 and formally known as the

Combined Code of Corporate Governance), which comprised five main principles of Leadership, Effectiveness, Accountability, Remuneration and Relationship with shareholders. Further, the Prudential Regulatory Authority operating under the Bank of England issued a supervisory statement "Corporate Governance: Board Responsibilities", which stipulate some requirements on the board structure for financial institutions. A half of the board (excluding chairman) should be independent non-executive directors (NED) (p. 7), a director who served the Board for more than 9 years deemed not to be independent and the need to separate the role of Chairman and CEO are few criteria stipulated for listed banks.

The existing literature that tests the corporate governance-financial performance relationship is inconclusive, especially the studies that focus on the financial sector. Therefore, this study aims to investigate the relationship between board structure and bank performance during the post crisis period using a recent dataset during the period of 2010-2015.This study focused on the association between the board structure and bank financial performance. Using a sample of 45 European banks comprised of 270 bank-year observations, the study aimed to identify the effect of board size, board composition and the gender diversity on the bank performance.

The findings of this study provide valuable insights to policy makers, and it is presumed that the results of this study are timely, due to the European Commission's increasing focus on improving corporate governance. At the first instance, the study finds that there is a positive relationship between both the board size and proportion of independent directors and bank performance. Also, the study finds evidence that gender diversity decreases bank performance. Interestingly, the study finds nonlinear relationships between board characteristics and bank performance when the quadratic term of the independent variable is controlled. Empirical evidence suggests that there is an inverted U-shape relationship between board size and bank performance, and the number ranges between 19-28 directors (Results differ based on the estimation method as well as the use of alternative proxies of performance). I.e. appointing additional directors beyond the above threshold will decrease bank performance. Also, regarding the proportion of independent directors, there is an inverted U-shape relationship and appointing a proportion of independent directors above 64% will decrease the bank performance. It is important to have an appropriate mix, as banks benefit from directors with their firm specific knowledge given through advisory roles. Interestingly, the study finds that there is a U-shape relationship between the proportion of female directors and bank performance. At first instance, empirical evidence shows there is a negative correlation, but appointing female directors above a critical mass of 34% will increase bank performance. This finding is consistent with the critical mass theory of Kanter (1977), showing that it is important to appoint a certain threshold of female directors to the board to obtain the benefits of their diverse skills and abilities.

The remainder of the paper is structured as follows: Section 2 discusses the theoretical background of corporate governance and firm performance relationship followed by a literature review and research hypothesis. Section 3 presents an overview of the institutional

background of banks in the European region and its corporate governance codes, Section 4 discuss the data and empirical model, Section 5 presents the empirical results, and finally, Section 6 summarises the study with a discussion of findings and areas for further research.

2. Theoretical background and literature review

2.1. Theoretical background

BODs of an organisation are entrusted with four functions: monitoring and controlling of the management, providing advice, monitoring compliance with the law and the creating a link between the firm and the external environment. (Mallin 2004; Monks & Minow 2004). The general understanding is that the structure of the board will affect the way the board performs the above functions. Therefore, board structure components like board size, the proportion of independent directors and gender diversity of a board are assumed to be linked to the effectiveness of the board and thereby, affect towards the firm performance positively or negatively.

There is no single theory that describes the effect of corporate governance on firm performance. The existing literature is mainly focused on the empirical findings of the studies conducted in this regard. Following Carter, Simkins and Simpson (2003), Carter et al. (2010), Boone et al. (2007) and Farag and Mallin (2017) seven theories were drawn from the various disciplines to provide an insight into the relationship between board structure and performance, namely agency theory, resource dependency theory, human capital theory, contingency theory, social psychological theory, the scope of operation hypothesis and the critical mass theory.

Agency theory assumes that a higher proportion of independent directors will lead to better monitoring, which will be helpful to overcome the agency problem (Hillman and Dalziel, 2003). Therefore, it is important that boards should comprise an appropriate mix of internal and external directors with different backgrounds and experiences (Hillman and Dalziel, 2003; Adam and Ferreira, 2009). More diverse boards with members from different backgrounds will be more independent and thus provide a better monitoring role (Carter, Simkins & Simpson, 2003; Carter et al., 2010). Further Adam and Ferreira (2009) found that female directors are more effective in relation to the monitoring function. Supporting the above view, Farag and Mallin (2017) and Carter et al. (2010) stated that female directors improve the monitoring role as well as lower the agency costs. However, agency theory is unable to provide a clear link between board diversity and financial performance (Carter, Simkins and Simpson, 2003; Carter et al., 2010).

Resource dependence theory is concerned with how organisational behaviour is affected by external resources the organisation utilises. As per Pfeffer and Salancik (2003) the board serves

as the link between the organisation and external environment. These external linkages are capable of the providing resources such as information and expertise, the creation of communication channels and providing support of the important groups in the external environment (Pfeffer and Salancik, 2003). Hillman, Cannella, and Paetzold (2000) suggest that different types of directors (internal members, business experts, support specialists and community influential) will provide different benefits to the firms. Therefore, more diverse boards (with external members and gender and ethnic diversity) will provide more valuable resources for better firm performance. For example, female directors can bring forward new opinions and ideas that would not happen in homogeneous boards (Mateos de Cabo et al., 2011). Hence, the resource dependency theory provides convincing arguments in support of board diversity.

The above argument is also supported by the **human capital theory,** which states that a person's education, experience and skills would be beneficial to the organisation (Becker, 1964). Therefore, diversity among directors will result in them having different human capital, which will benefit the overall firm performance (Terjesen et al., 2009). Hillman et al. (2002) find that gender diversity, as well as ethnic diversity, give people different business expertise. For example, female African-American directors are less likely to be business experts than African-American male directors. Therefore, gender diversity will result in the unique human capital, which could either affect the financial performance of the firm positively or negatively. (Carter et al., 2010)

Contingency theory suggests that the impact of board diversity on firm performance will be affected by the external and internal environment in which the firm operates (Carter et al., 2010). Gender diversity will benefit some organisations and not others, and it will have a different impact during different time periods (Adam and Ferreira, 2009). Consistent with the above argument, a study conducted using a sample of several firms over a specific period gave no effect as the positive and negative effects of diversity offset each other (Carter et al., 2010).

Boone et al. (2007) in their study attempted to find out the forces that drive the board size and composition. Following the work of Fama and Jensen (1983) and Coles et al. (2008), Boone et al. (2007) presented the **scope of operation hypothesis** stating that the Board structure is driven by the scope and complexity of firm operations. Supporting the above hypothesis, they found that firm size, firm age and number of business segments have a positive effect on the number of directors and proportion of independent directors. It implies that when firms grow, the board size as well as the proportion of independent directors also grow, providing increased net benefits of monitoring.

The social psychological theory of minority status poses an opposing argument to the favourable view on the inclusion of female directors in corporate boards. According to Westphal and Milton (2000), the above concept states that the majority status group has a more powerful influence on the decision-making process and the minority group, i.e., the

women, in this case, will not have enough power to exert influence. As a result, the benefit of having a diverse board will not be realised.

Supporting the above, the **critical mass theory** of Kanter (1977) stated that until a certain threshold or a "critical mass" is appointed to the board, the abilities and the skills a female director brings to the board is undervalued. The empirical study conducted by Joecks, Pull and Vetter (2013) confirmed the above findings and the above theory could be linked to the reason for the introduction of gender quotas as well.

The existing theoretical underpinnings do not give a clear link between the nature of the relationship. Hence, the board size and the composition of the board (proportion of external directors and female directors) may have both positive and negative effects on firm performance. The next section will discuss the empirical findings of the literature on the topic.

2.2. Literature review and research hypothesis

2.2.1. Board structure and performance in the banking industry

The structure of the BOD and firm financial performance is a widely-investigated topic in business literature which goes the back to the early 1990s (Adam and Mehran, 2012). However, most of the existing literature that focused on testing the above relationship overlooked banking institutions (Adam and Mehran, 2012). The studies that focused on the relationship between board structure and bank performance have been conducted by Andres & Vallelado (2008), Adam and Mehran (2012), Pathan and Faff (2013), O'Sullivan, Mamun and Hassan (2015) and Salim, Arjomandi and Seufert (2016). Most of the above studies that focused on the banking sector used sample data of the US banks (E.g. studies conducted by Andres & Vallelado, 2008; Pathan, 2009; Adam & Mehran, 2012; Pathan and Faff, 2013; and O'Sullivan, Mamun & Hassan, 2015). The impact of board structure on European banks has not been a study area with greater attention. According to the knowledge of the researcher, studies conducted by Farag and Mallin (2017), Mateos de Cabo, Gimeno and Escot (2011) and Mateos de Cabo et al. (2012) used European banks as the sample in their studies. But there has been no study conducted to test the impact of bank performance of European banks, which capture board structure variables such as board size, board independence and gender diversity. Therefore, it is important to carry out this study to fill the existing gap in the current literature.

2.2.2. Board size and performance

The most common finding in the existing literature is that there is a negative relation between board size and firm performance (Yermach, 1996; Eisenberg et al., 1998 and Hermalin and Weisbach, 2003). Jensen (1993) argued that as the board became larger, boards became less effective in monitoring and management, and faced increased decision-making time due to the issues of communication and coordination as well as free rider problems. Further, the directors in large boards have limited time expressing their opinion at the Board meetings (Liptin and

Lorsch, 1992). On the contrary Dalton et al. (1999) argued that large boards are an added advantage to the firms as they are a combined source of expertise and resources. In a study focused on non- financial firms, Coles et al. (2008) found that the relationship between board size and Tobin Q is U-shaped. That is, in more complex firms, performance increases with larger boards. They argue that, advisory benefits of larger boards outweigh the cost of maintaining larger boards, especially in the case of complex firms. They further comment that most existing literature found a negative relation in the sample of non-financial firms because most of the samples consisted of simple boards. The above finding is consistent with the scope of operations hypothesis by Boone et al. (2007) which stated that for larger and complex firms the benefits of the monitoring and advisory role of directors are higher than the cost of maintaining larger boards, and hence provided an argument for having larger boards.

The banking sector results are mixed as some studies found a positive relation, inverse relation as well as a concave relation. E.g. Adam and Mehran (2012) conducted a study using 35 listed bank holding companies (BHC) in the USA and found that board size is positively related to the performance. A similar study conducted by O'Sullivan, Mamun and Hassan (2015) using the largest 150 BHC in the US also found that board size, CEO tenure and board tenure enhance the bank performance in normal times, but during the crisis period board size had a negative effect on Tobin Q ratio. The findings of the above studies are consistent with the findings of Coles et al. (2008) and Boone et al. (2007); that due to the complexity of banks, the benefits of large boards will outweigh the costs of maintaining large boards. Adam and Mehran (2012) presented two reasons for having larger boards. The bank board grows after a merger and acquisition (M&A) to accommodate additional directors from the target company. Secondly, many complex organisations have many subsidiaries within their own boards. To facilitate coordination within the group, it is important to have representatives of the subsidiary companies on the bank boards. As a result, having larger boards due to the M&A activity and to facilitate the complex organisational structure suggests that the effect of the board size on the bank performance may be positive. On the contrary, the study conducted by Pathan and Faff (2013) using a sample of USA BHC's, during the period 1997-2011 found that, board size decreases the bank performance. Liang, Xu and Jiraporn (2013) also yielded similar results using a sample of 50 largest Chinese banks that board size has a significantly negative impact on bank performance.

Based on the above discussion, the researcher followed the arguments made by Adam and Mehran (2012) and Coles et al. (2008) and presumed that larger boards will benefit the banks due to the complexity of the banks. The first hypothesis related to board size is as follows;

H_1: There is a positive relationship between board size and bank performance.

Even though the researcher hypothesizes that board size positively relates to performance, there is a trade-off between advantages of larger boards (benefits of advisory and monitoring roles) and disadvantages (coordination, control and decision-making problems). Similar to the

findings of Coles et al. (2008), Andres and Vallelado (2008) found an inverted U-shaped relation between bank performance and board size using a sample of 69 large commercial banks from six OECD countries. Findings show that boards that are not excessively large affect performance positively, as when the number of directors reaches 19, Tobin's Q starts to diminish. The findings challenged the dominant belief of "one-size-fits-all" in boards, and this is particularly true, for the banking industry operates in a complex and uncertain environment (Andres & Vallelado, 2008). As discussed above, this study is interested in finding whether there is a nonlinear relationship between board size and bank performance. Therefore, the second hypothesis is formulated as follows;

H_2: There is a nonlinear relationship between board size and the bank performance.

2.2.3. Board independence and performance

According to Adam and Ferreira (2007), BODs play a dual role as advisors as well as the role of monitoring of the management. As per the theoretical governance literature, the optimal board composition should try to achieve a balance between advising and monitoring needs. Independent directors are considered as better monitors of managers due to their willingness to maintain their reputation in the Directorship market (Fama & Jensen, 1983). Independent directors are tougher monitors (Hermalin & Weisbach, 2003) as well as they can offer valuable advice from different perspectives. The role of external directors is more important in complex firms, which need better monitoring and advice due to the complex business environment.

Coles et al. (2008), using a sample of non-financial firms, found that the proportion of independent directors are positively related measures of firm complexity and the above finding is consistent with the scope of operation hypothesis presented by Boone et al (2007) as well. On the other hand, they found that for R&D-intensive firms, for which the firm-specific knowledge of internal directors is relatively important, a higher fraction of insiders on the board is important. Therefore, the potential disadvantage of external directors is that they lack firm specific information which may be problematic for their effective advisory role (Adam and Ferreira, 2007).

What does hold true for the banking institutions? The corporate governance mechanism in banks plays a special role due to the unique functions of the banking institutions. Studies on the corporate governance of the banking industry acknowledge the problems regarding complexity and regulation (Andres & Vallelado, 2008). The complexity of a bank arises due to financial engineering not being transparent, complicated financial statements, underestimated investment risk, overstated quality of loans etc. (Levine, 2004). To manage the complexity, it requires a board who can monitor managers effectively and be capable of giving valuable advice with firm-specific knowledge. Regulations also plays an important role in financial institutions. There might be restrictions imposed on ownership structures, board structures and as a part of their supervision regulators monitor the bank boards as well (Andres & Vallelado, 2008).

As mentioned earlier external directors are better monitors of the management, but an excessive proportion of independent directors will reduce the effectiveness of the advisory role of the board as it prevents executive directors with firm specific knowledge to join the board (Adam and Ferreira, 2007). Therefore, there is a trade-off between pros and cons of the proportion of outside directors.

Empirical studies conducted on banks showed mixed results relating to the relationship between independent directors and the firm performance. The findings of existing studies show a positive, inverse, concave relationship as well as no relationship at all. Some studies show a positive relationship as they can improve earnings quality (Mishra & Nielsen, 2000), lower the cost of debt financing (Anderson et al., 2004) and improve credit rating (Ashbauh-Skaife et al.,2006). Adam and Mehran (2012) found board independence is not related to performance, as measured by Tobin Q. Andres & Vallelado (2008) found an inverted U-shaped relation between the proportion of outsiders and firm performance, i.e. putting more external directors creates more firm value, but when reaching a higher proportion of external directors, Tobin Q starts to diminish. It is important to identify the optimal mix of executive and non-executive directors to create more value for the firm than excessively independent boards. To be efficient boards also should include executive directors, whose insider knowledge is as important as a non-executive director's ability.

According to Pathan and Faff (2013) banks with more independent directors perform worse. Due to the high information asymmetry, complexity and the highly-regulated environment of banks, the addition of more independent directors does not reflect an improved performance. This finding is consistent with the argument of Fama and Jensen (1983) that complex firms with high information asymmetry operate in an uncertain environment, and will benefit from more inside directors with firm specific knowledge. Supporting the above argument, Duchin et al. (2010) found a positive relation between board independence and firm performance in non-bank firms with low information asymmetry and less complexity. Alternatively, Subrahmanyam et al. (1997) argued that the intense regulation and severe penalties discouraged qualified and experienced directors from serving on bank boards. Therefore, the addition of new independent directors does not create value. Adam and Ferreira (2007) in their study of "Theory of friendly boards" stated that banks with high information asymmetry should not rely on monitoring by independent directors.

Therefore, after considering the above arguments the researcher concluded that independent directors and bank performance have a positive relationship since independent directors are better monitors of management. To test the above-expected relationship the following hypothesis was developed:

H_3: There is a positive relationship between the proportion of independent directors and the bank performance.

As discussed above, since excessively independent boards are not beneficial it is important to find out the optimum mix of internal and external directors.

Following the study of Andres and Vallelado (2008) the fourth hypothesis was developed to find out the optimal mix of internal and external directors.

H_4: There is a nonlinear relationship between the proportion of independent directors and the bank performance.

2.2.4. Gender diversity and performance

In the recent years, increased importance was given to boards with gender diversity, especially in the aftermath of the financial crisis. Regulators at present are focusing on imposing gender quotas to the firm boards. The impact of gender diversity in the boardroom has been a well-researched finance topic throughout the years(Carter, Simkins & Simpson, 2003; Adam & Ferreira, 2009; Pathan & Faff, 2013; Farag & Mallin, 2017). However, the percentage of female directors in the boards has increased steadily, but very slowly over the years. According to the European Commission report (2015), an average of 21.2 % of the board members of the largest publicly listed companies in the EU are women, a notable increase from 11.9% in 2010.

The existing literature suggests that female directors are capable of creating firm value, as they are hardworking and have better communication skills which will contribute to an enhanced problem-solving and decision-making ability of the board (Robinson & Dechant, 1997). Adam and Ferreira (2009) found that female directors have fewer attendance problems and greater the percentage of female directors better the attendance of male directors. Further, he stated that female directors mostly sit in monitoring committees such as audit, nomination and corporate governance committees, and gender diverse boards put more effort to monitoring. Supporting the above argument, Eagly and Carli (2003) found that women tend to come better prepared for meetings and take their responsibility seriously. As per this finding that women put more effort into their task, it could be argued that their effort improve the board effectiveness.

There is mixed evidence on the impact of the gender diversity on firm performance in studies conducted in the non-financial sector. Adam and Ferreira (2009), using the data on Standard & Poor 500 companies found that female directors have an overall negative effect on the firm performance, which was consistent with the argument that too much board monitoring can decrease shareholder value. Having a larger proportion of female directors will be beneficial if additional monitoring would enhance firm value. Further, they found that for firms with weaker shareholder rights, gender diversity has beneficial effects, while it has detrimental effects on companies with strong shareholder rights.

Using a sample of major US corporations, Carter et al. (2010) found that there is no significant relationship between gender diversity of the board and financial performance. The findings

of the above are consistent with the contingency theory that the effect of gender diversity on firm performance is dependent on various internal and external environments. Thus, gender diversity may be desirable in some firms and not in others. Similarly, Randoy, Thomsen, & Oxelheim, (2006), Farrell and Herschg (2005) and Francoeur, Labelle and Desgagne (2007) found that gender diversity has no impact on financial performance.

On the contrary, Carter, Simkins and Simpson (2003) and Campbell and Minguez-Vera (2008) found a positive relationship between gender diversity and performance as measured by Tobin Q for a sample of companies from USA and Spain, respectively. Similarly, Kim and Starks (2016) presented evidence that a higher percentage of female directors presented higher company valuation using the firms in the S&P Small Cap 600 Index as the sample.

There have been relatively fewer studies conducted on the relationship between gender diversity and the performance in the banking industry and the results of those studies are inconclusive. Pathan and Faff (2013) found that gender diversity improves the bank performance prior to the introduction of Sarbanes Oxley Act(SOX)(1997-2002), and positive effect of gender diversity decreases during the post-SOX (2003-2006) and crisis periods (2007-2011), interpreting that more female directors beyond the desirable level prevent the possibility of the inclusion of more capable male directors. Also, the main reason for including more female directors in the post-SOX period may be due to public pressure rather than the best choice.

Joecks, Pull, and Vetter (2012) found a U-shaped relationship between gender diversity and firm performance. They found that at first gender diversity affects firm performance negatively. Gender diversity improves firm performance only after a critical mass of 30% of female directors are reached. Farag and Mallin (2017) found that relationship between gender diversity and financial performance is nonlinear and has an inverted U-shaped relationship for unitary boards. That is, appointing female directors up to 21% increases the financial performance, while beyond 21% it decreases the bank performance. The above findings are consistent with the arguments that female directors are risk averse compared to male counterparts and hence reduce bank performance. Consistent with the critical mass theory of Kanter (1977), they found that the relationship is U-shaped in management boards of the dual board structures and appointing female directors beyond a critical mass of 27% has a positive impact on firm financial performance.

There is no formal theory which explains the effect of gender diversity on firm performance. The current knowledge is mainly related to empirical findings of existing studies (Pathan & Faff, 2013). The differences in results of the studies are due to different samples, time periods, industry coverage as well as the econometrics problems such as endogeneity. According to Wintoki et al. (2012) due to the presence of endogeneity of the governance variables, the findings of such studies will be biased if the researchers do not adequately control reverse causality and unobservable heterogeneity.

Based on the existing literature, female representation on the boards has advantages as well as disadvantages. The existing understanding is that gender diversity will enhance a firm's value, and based on the resource dependency theory and human capital theory, Farag and Mallin (2017) argued that female directors will bring the board a degree of diversity in backgrounds, experiences and opinions, which may lead to better financial performance. Therefore, following the studies of Farag and Mallin (2017) and Pathan and Faff (2013), a positive relationship is expected between the proportion of female directors and bank performance, assuming gender diversity will enhance the monitoring and advisory role of the board of directors. Based on the above, the following hypothesis is developed regarding gender diversity.

H_5: There is a positive relationship between the proportion of female directors and the bank performance.

The study is also interested in finding whether there is a nonlinear relationship between the proportion of female directors and bank performance. That is whether there is a critical mass of female directors need to be present in the bank boards to get the benefit of gender diversity. Therefore, the final hypothesis of the study is developed as follows.

H_6: There is a non-linear relationship between the proportion of female directors and bank performance.

3. Institutional background

3.1. Corporate Governance in the European Union (EU)

The EU has grown into a union of 28 member states accounting for more than 24%[2] of the world's GDP. The EU is a region where business cooperation among member states are common, and it facilitates the single market among the member states. The EU has become one of the fastest changing corporate governance environments in the world due to the European Commission's (EC) focus on corporate governance.

In 2012, the EC published the EU Action Plan for developing corporate governance practices among EU member states. The member states have their national corporate governance codes (e.g. UK Corporate Governance Code, CG Codes and Principles in France) and divergences of practices exist among the member states (International Finance Corporation, 2015).

The board structure of EU consists of either unitary or dual Boards. Out of 28 Euro member states 8 countries have a unitary board system, 10 countries have a dual board system and the remaining 10 countries follow a hybrid approach where companies are allowed to choose

[2] Share of World GDP, 2014: The EU in the world 2016, a Eurostat Publication. Next planned update is in June 2018

between unitary and dual boards (EC, 2013). Table 3.1 below lists the member states with their board structures.

Based on the survey conducted by Heidrick and Struggles (2014), the board sizes and the board composition, i.e. the proportion of executive and non-executive directors vary significantly between member states. Also, there has been a growing focus on increasing board diversity especially gender diversity in the corporate boards (IFC, 2015).

Table 3-1: Board Structure of EU countries followed by date of membership

Unitary Boards	Dual Boards	Hybrid
Belgium (1952)	Germany (1952)	**France (1952)**
Ireland (1973)	Netherlands (1952)	**Italy (1952)**
Spain (1986)	Austria (1995)	**Portugal (1986)**
United Kingdom (1973)	Czech-republic (2004)	Bulgaria (2007)
Sweden (1995)	Denmark (1973)	Hungary (2004)
Greece (1981)	Poland (2004)	Luxemburg (1952)
Malta (2004)	Finland (1995)	Slovenia (2004)
Cyprus (2004)	Slovakia (2004)	Lithuania (2004)
	Latvia (2004)	Croatia (2013)
	Estonia (2004)	Romania (2007)

Source: IFC (2015) and European Commission (2013). Countries denoted in bold letters are the sample of countries used in this study.

Regulation on board size: The Basel Committee on Banking Supervision (BCBS,2015) suggests that a board should comprise of individuals to commensurate with the size, complexity and risk profile of the bank. In line with the above national CG codes did not stipulate a strict limit on the number of board of directors but stated that the board size should be in line with the size and complexity of the firm. Furthermore, in line with the above provision, individual banks have set limits on the minimum and a maximum number of board directors, which correlate with the size and complexity of business operations. E.g. MedioBanca in Italy has set a limit of a maximum of 15 directors on the board (Medio Banca Annual Report 2016/17).

Regulation on board composition: As per the BCBS guidance (2015), a Board should comprise a sufficient number of independent directors to facilitate effective oversight (BCBS,

2015). Regarding board composition, there are differences in national regulation. E.g. The UK CG code suggests that the best practice is that at least half of the board, excluding the chairman, should comprise of independent non-executive directors (UK Corporate Governance Code, 2016), whereas in the CG code in Italy the proportion of independent directors should be 1/3 of the total number of board members (Corporate Governance Committee-Borsa Italiana, 2015).

Regulation on gender diversity: Norway was the first country to introduce a compulsory gender quota of 40% in 2003, and following this Spain (2007), Belgium (2011), France (2011), Italy (2011), Netherlands (2013) and Germany (2016) also introduced compulsory gender quota targets. Countries such as Austria and Greece also have imposed quotas for state owned companies (European Commission, 2015). In 2012, the EU Commission proposal set a gender quota of 40% to improve the gender balance of Non-Executive Directors (NED) in listed companies by 2020. On November 20, 2013, the European parliament approved the proposal with a strong majority, confirming the broad consensus towards the initiative (EC, 2015).

Table 3-2: Country statistics on gender quota

Country	Quota (%)	Date of Compliance or expected date of compliance	Share of women on boards (*)
Belgium	33%	2017	23.4%
France	40%	2017	32.8%
Germany	30%	2016	25.4%
Spain	40%	2015	16.8%
Italy	33%	2015	25.8%
Netherlands	30%	2016	23.8%
Austria	State owned companies 35%	2018	17.8%
Greece	33%(State owned companies)		10.3%

**Latest update as of April 2015: European Commission Database on Women on Decision Making*

3.2. Banking sector in the EU

The total assets of the EU banking sector stood at € 27.7 trillion at the end of 2015. Based on the size of the banking sector assets, France and Germany are the largest, followed by Spain and Italy, respectively (European Central Bank, 2016).

3.3. Corporate governance of the banks in the EU

Corporate governance in banking institutions received much attention after the global financial crisis. Many hold the view that banking institutions should have strict corporate

governance requirements than other non-financial firms. Governance weaknesses at banks play a significant role in increasing riskiness and transmitting the problems of the banking sector across the economy. Therefore, bank supervisors have identified the importance of sound corporate governance practices to the safe and soundness of the banking institution.

In October 2013, a single supervisory mechanism was established in the EU, and the European Central Bank (ECB) was entrusted as the supranational supervisory body to oversee banking supervision. Under the European System of Financial Supervision (ESFS), three supervisory authorities together with the national supervisors and the European Systemic Risk Board undertake a three-tier approach to supervision. The ECB or European Banking Authority has not mandated any CG requirements for banking institutions; hence banks in the member states need to follow their respective national code of CG.

In some of the EU countries, the national supervisor has mandated CG requirements for banks in addition to the national CG codes. E.g. in the UK the Prudential Regulatory Authority (PRA) has issued a supervisory statement stating the aspects of CG they devote attention to in the course of its supervision function.

Also, the BCBS has issued a consultative document on "Corporate Governance principles for banks" which will be followed by the member jurisdictions.

4. Data and methodology

4.1. Sample size

The sample consists of the annual data of the 45 largest European banks with a unitary board system as per the Banker's Top 1000 World Bank Report 2013.[3] The report ranks the financial institutions across the globe based on several parameters such as strength, size, soundness, profit and performance. The annual data of the aforementioned banking institutions, which comprised of unitary boards was collected over the period from 2010-2015. Following the study of Farag and Mallin (2017), the sample was constrained to the banks in the European Union (EU) and the members of the European Economic Area (EEA) due to the similar regulatory and governance backgrounds. Also, other credit institutions including mortgage banks and building societies were excluded from the sample due to the differences in the business model.

Out of the EU countries with unitary boards, Cyprus and Malta were excluded due to the non-availability of data. From the countries with hybrid board structures, the sample that was selected consisted of banks with unitary boards. Bulgaria, Hungary, Luxemburg, Slovenia,

[3] Banker's Top 1000 World Bank Report 2013 report was the latest available at the library of University of Birmingham.

Lithuania, Croatia and Romania were excluded as it has less than 2 banks in the Top 1000 banks list as well as the non-availability of data. As a result, the final sample consists of Belgium, Ireland, Spain, United Kingdom, Sweden, France, Greece, Italy and Portugal from the EU countries. Switzerland was selected as a sample country as it is a member of the EEA and has access to the single market along with the other EU countries. Following the study of Farag and Mallin (2017), Norway was excluded because it introduced a compulsory gender quota for listed companies in which female directors should be at least 40%. Therefore, the final sample consists of 10 countries in the European region, which include 45 of the largest European banks with unitary board structures.

The corporate governance data were mainly collected from the DataStream Asset 4 ESG database, and the rest of the governance data were hand collected from the annual reports. Financial data was obtained from DataStream, Thomson one, Fitch Connect and Bloomberg databases. The dataset is an unbalanced panel dataset with 270 bank-year observations of 45 banks over the period from 2010-2015. Table 4.1 below illustrates the distribution of banks across the 10 countries.

Table 4-1: Country-wise sample

Country	No. of banks in the sample
Belgium	2
Ireland	3
Spain	6
United Kingdom	5
Sweden	4
France	3
Greece	4
Italy	9
Portugal	3
Switzerland	6

Source: Compiled by the Author

4.2. Description of variables

Measures of bank performance

Following the study of Pathan and Faff (2013), four alternative proxies for bank performance (PEFOR) were used to investigate the relationship between board structure and bank performance. Return on average assets (ROAA), net interest margin (NIM), Tobin Q ratio (Q) and stock return (SR) were used as the proxies for bank performance. **ROAA** was computed as net income as a percentage average book value of total assets of the two most recent years. **NIM** is a commonly used performance measure for the bank's financial performance. It is calculated as net interest income (gross interest minus total interest

expense) as a percentage of average earning assets. Earning assets include loans that generate interest income. Many studies conducted to test the effectiveness of corporate governance mechanisms used Tobin Q as one of the dependent variables. (Pathan & Faff, 2013; Andres and Vallelado, 2008; Adam & Mehran, 2012; Caprio et al., 2007). Tobin Q is computed as the sum of market value of equity plus the book value of liabilities divided by book value of total assets. A Tobin Q of higher than one reflects the firm's comparative advantage, while lower than one reflects poor utilisation of resources. (Campbell & Mínguez-Vera, 2008; Rose, 2007). Since all the banks in the sample are listed, SR was used as a proxy for banks performance as well. **SR** is the mean of the daily stock returns in a year. The daily stock return is calculated as the ratio of logarithmic stock prices. The study includes various proxies of performance to confirm that results are robust to changes in the dependent variable. Even though Tobin Q is the most common measure of performance in corporate governance studies, Andres and Vallelado (2008) argued that the high leverage of banks biases the Q ratio to be one. Due to this, alternative performance measures were selected, which comprised of accounting based measures of performance (ROAA & NIM) and market-based measures of performance (SR).

Measures of Board Structure/explanatory variables

Studies which test the impact of corporate governance on firm performance commonly used three variables to measure the board structure. i.e., the natural logarithm of board size (LnBS), board independence (IND) and gender diversity (FEMALE). **LnBS** is the natural logarithm of a total number of directors in the board. Natural logarithm was used to account for large variations of the data in the sample (Minimum 3, maximum 30). **IND** is the percentage of independent[4] Directors in the board and **FEMALE** is the percentage of female directors on the board. As per the detailed explanation provided in the literature review and research hypothesis, this study expects a positive relationship between board size, the proportion of independent directors, the proportion of female directors and the bank performance.

[4] Data Stream Asset 4 ESG database define Independent Director as a Director who is" not employed by the company; not representing or employed by a majority shareholder; not served on the board for more than ten years; not a reference shareholder with more than 5% of holdings; no cross-board membership; no recent, immediate family ties to the corporation; not accepting any compensation other than compensation for board service.

Table 4-2: Description of variables

Notation	Variable Name	Description of variables	Source	Expected Sign
ROAA	Return on Average Assets	Net income divided by the average book value of total assets.	Fitch Connect	
NIM	Net Interest Margin	Net interest income as a percentage of average earning assets.	Fitch Connect	
Q	Tobin Q Ratio	The sum of market value of equity plus the book value of liabilities divided by the book value of total assets.	Calculated using data of Fitch Connect	
SR	Stock Return	The mean of the daily stock returns in a year. The daily stock return is computed as the ratio of logarithmic stock prices	Bloomberg daily stock prices	
Explanatory Variables				
LnBS	Natural logarithm of Board Size	Natural logarithm of the total number of directors at the end of fiscal year	**DataStream** Board Size	+
IND	Board Independence	Independent Directors as a % of total directors	**DataStream** Value: Board Structure/Independent board members	+
FEMALE	Gender Diversity	female directors as a % of total directors	**DataStream** Value: Board Structure/Board Gender Diversity	+

Notation	Variable Name	Description of variables	Source	Expected Sign
Control Variables				
TA	Bank Size	Banks total assets in billions as a proxy for bank size	Fitch Connect	+
CAPITAL	Bank Capital	The regulatory measure of bank's capital: Tier 1 capital adequacy ratio	Fitch connect	+
MERGER	Merger and Acquisition	A dummy variable of 1 if M&A during the sample period and zero otherwise.	Bloomberg	+
LnGDP	Gross Domestic Product	Natural logarithm of GDP in Euros	Bloomberg	+

Source: Compiled by the Author

Control Variables

Following the previous studies of Pathan and Faff (2013), Farag and Mallin (2017), Andres and Vallelado (2008) and Adam and Mehran (2012), 4 other control variables were used to capture much of the error term in the regression model. The control variables were selected to account for differences in the banks' business structure and risk profile as well as to reflect on the differences between the countries. I.e., it is aimed at controlling bank and country heterogeneity.

Bank's total assets measured in billion euros as a proxy for bank size (**TA**) as the performance of large banks may differ from smaller banks, and larger banks tend to have larger boards. Tier 1 capital adequacy ratio (**CAPITAL**) as a measure of the risk appetite of the Board and the management of risk. Higher CAR represents higher loss absorbent capacity and risk averseness. **MERGER** is a dummy variable indicating merger and acquisitions in the sample period, because following an M&A the bank board size tends to increase to accommodate directors from the target company. The natural logarithm of GDP in Euros (**Ln GDP**) to reflect the macroeconomic condition of each country was also included in the regression model. Firm and year dummies were used to capture firm and time heterogeneity, respectively.

4.3. Methodology

Panel data analysis is the most efficient tool to use when the sample consists of a mixture of cross-sectional and time series data. The panel data structure can take into account the heterogeneity, i.e., the specific features among each bank being studied (e.g. management style

and quality, business strategy). Pooled Ordinary Least Squares(OLS) estimation is biased and inconsistent when there is an unobserved effect and it correlates with the independent variable (Andres & Vallelado, 2008).

The panel least squares model can be specified as either using fixed effects or random effects. The fixed effect model captures the unobserved heterogeneity arising from firm specific time invariant variables. In the presence of the unobserved bank fixed-effect, panel 'Fixed-Effect' (FE) estimation is commonly suggested (Wooldridge,2002). A number of studies conducted on the topic used the fixed effect model opposed to the random effect model due to the possibility of capturing unobserved heterogeneity (Adam & Mehran, 2012; Adam & Ferreira, 2009; Pathan & Faff, 2013; Farag & Mallin, 2017).

A central assumption in random effects estimation is the assumption that the random effects are uncorrelated with explanatory variables. The study employed the Hausman Specification Test to select the appropriate model. In this test the Null hypothesis (H_0) is that there is a zero correlation between the random effects and the explanatory variables (Lindquist, 2004). If the null hypothesis is rejected there is no random effects, and fixed effects can be applied. Results of the Hausman Specification Test favours the use of fixed effects since the Prob>chi2 is less than 0.05 for all the four dependent variables.

When deciding on the appropriate estimation method, it is important to consider alternative methods used in prior studies. Many academic literatures on corporate governance argue about the problem of endogeneity[5] in governance variables. Two main sources of endogeneity exist in the governance studies. Namely, Unobserved Heterogeneity [6]and Reverse Causality[7]. To address the above concern, some studies used the fixed effects panel which is estimated to control firm heterogeneity and limit the omitted variable bias (Adam and Mehran, 2012; Adam and Ferreira, 2009).

Adam and Ferreira (2009) used the firm fixed effect to capture the effect of any other time invariant firm characteristics that might be driving the result other than the governance variables used in the regression model. For example, variables such as corporate culture (Adam & Ferreira, 2009) and the ability and effort of directors (Pathan & Faff, 2013). By the incorporation of fixed effects, it is assumed that individual specific effect (μi) captures all of the variables that affect the firm performance cross-sectionally that do not vary over the time (Brooks, 2008). Adam and Mehran (2012) included year dummies and firm fixed effects and used a rich set of governance variables (to limit the omitted variable bias and to avoid spurious

[5] ***Endogeneity,*** *i.e. the firm performance is correlated with the error term than the governance variables.*

[6]**Unobserved Heterogeneity** *Unobserved differences across the units being studied like ability and effort, performance of the firm is merely a result of underlying unobservable factor)*

[7] ***Reverse Causality****: The relation between two events that are happening at the same time. e.g. board structure affects bank performance and in the same time bank performance drives governance structure) See, for example, Pathan and Faff (2013); Farag and Mallin (2017); Andres and Vallelado (2008); Adam and Ferreira (2009).*

correlation) to address the endogeneity concerns. But the researchers who used the fixed effect model accepted that their results would be biased by reverse causality. Researchers such as Pathan and Faff (2013), Farag and Mallin (2017) Wintoki et al (2012), Andres and Vallelado (2008) used the two step system GMM adopted by Arellano and Bover (1995) and Blundell and Bond (1998) as the primary estimation to control all sources of endogeneity. But the scope of this study is the association of governance variables on bank performance and hence ignored the problem of reverse causality. This will be further discussed in the limitation section of the study.

Following the study of Adam and Mehran (2012) and Adam and Ferreira (2009), the main estimation method used is the firm fixed effects with year dummies. It is important to incorporate the "year dummies" in panel regressions to control the effect of aggregate time series trends, which do not describe causal relationships.

The following regression equation will be used to test the six-main hypotheses (H_1, H_2, H_3, H_4, H_5, H_6).

$$(PERFOR)_{i,t} = \propto_0 + \beta_1(LnBS)_{i,t} + \beta_2(IND)_{i,t} + \beta_3(FEMALE)_{i,t} + \tau_1(TA)_{i,t} + \tau_2(\mathrm{CAPITAL})_{i,t} + \tau_3(MERGER)_{i,t} + \tau_4 ln(GDP)_{i,t} + \mu_{i,t} + \varepsilon_{i,t}$$

Where subscript *i* denotes individual banks and *t* denotes the time. $(PERFOR)_{i,t}$ is the dependent variable (i.e. ROAA, NIM, Q, SR) The coefficient α, β, τ are the parameters to be estimated. μ is the remaining unobserved fixed effect for bank i. and ε_{ij} denotes the remaining disturbance term.

In addition to the results of the fixed effect model, results of the Pooled OLS model will be presented as a robustness check in the next chapter. The data were analysed using the Stata SE 14 software package.

5. Empirical results

5.1. Summary statistics

Table 5.1 below presents the descriptive statistics of the main independent and dependent variables used in the study. The average board size in the sample is 15 directors, where the maximum is 30 and minimum is 3 directors. The large discrepancy may be attributed to the non-availability of regulations related to the number of board of directors in the sample of 10 countries used in this study. The numbers are similar to the study conducted by Farag and Mallin (2017) using a dataset for the period of 2004-2012. The average proportion of independent directors is 53% with a standard deviation of 25% and ranges from 0% to 98%. It was noted in the sample of countries that Belgium has the highest proportion of independent directors. The proportion of female directors ranges from 0% to 53%, with an average of 18%. This number is higher than the 10% average reported by Farag and Mallin

(2017) in their sample. The number of female representation improved over the last few years due to various measures taken by EU member states to promote gender diversity and the imposition of mandatory gender quotas. Furthermore, the average capital ratio was 12.8% with a minimum of 6.1% and a maximum of 29.3%. There has been a merger at least one time for around 20% of the sample of banks in the study during the sample period. Larger discrepancies were noted in the proxies for financial performance whereas average ROAA is -5.6% and ranges from 4.16% to -145%. The main reason behind this is the poor financial performance of the banks in countries such as Greece, Italy and Ireland as they are still recovering from the aftermath of the GFC and the Eurozone crisis. Country wise summary statistics will be discussed in the next paragraph. The description of other variables was omitted for brevity.

Table5-1: Descriptive statistics

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
BS	270	15.21	5.265	3	30
IND	270	0.534	0.258	0	0.980
Female	270	0.183	0.117	0	0.538
ROAA	270	-0.0569	0.889	-14.60	0.0416
NIM	270	0.0136	0.0275	-0.423	0.0390
Q	268	1.042	0.170	0.906	1.878
SR	258	-0.0008	0.0031	-0.0228	0.0063
TA	270	471.7	581.1	0.159	2,213
CAPITAL	270	0.128	0.0455	-0.0610	0.293
MERGER	270	0.204	0.403	0	1
LnGDP	270	27.13	1.035	25.77	28.58

Please refer table 4.2 for the definition of each variable.

As represented by figure 5.1 below, Portugal (20) has the largest number of Board of Directors followed by Italy (19.7), Belgium (17.4) and France (17.2). Figure 5.2 below represents the average proportion of independent directors on the board in the sample of 10 countries from 2010—2015.The highest proportion of independent directors was evident in the sample banks of Belgium (94%).Countries such as Portugal, Italy and Greece only have 1/3 of directors as independent directors, and in most countries, at least half of the directors are comprised of independent directors. The differences are due to the differences in national codes of corporate governance. E.g. in Italy the CG code mandated at least 1/3 of independent directors on the board and as per the UK code of corporate governance, it should be at least half. France (36%) and Sweden (35%) have the highest proportion of female directors in the board, while Portugal (5%) and Greece (11%) have the lowest representation of female directors (Figure 5.3). The higher proportion of female representation in France is attributed to the gender quota of 40% which is mandatory by the year 2017. Despite having gender

quotas Spain, Italy and Greece have low female representation in the boards. Figure 5.4 below presents the average proportion of female directors in the sample of 10 countries year by year and shows that the average proportion increases from 13.8% in 2010 to 24.9% in 2015. Figure 5.5 below summarises the cross-country analysis of average values for independent and dependent variables.

Figure 5-1: Average Board Size by country 2010-2015

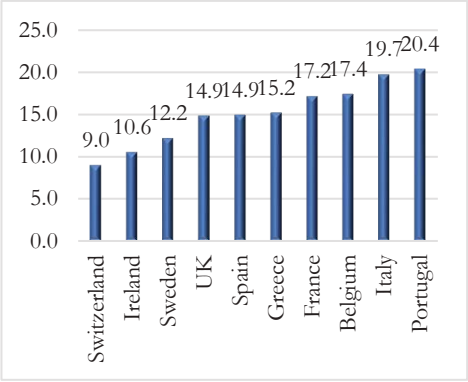

Figure 5-2: Proportion of average independent directors by country 2010-2015

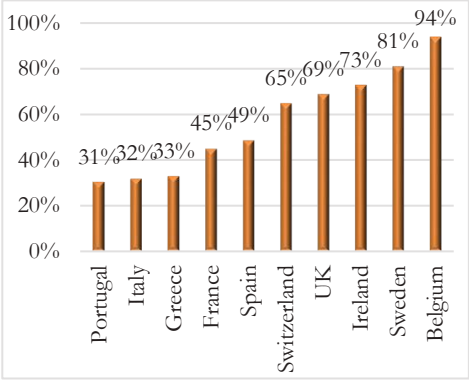

Figure 5-3: Average proportion of female directors by country 2010-2015

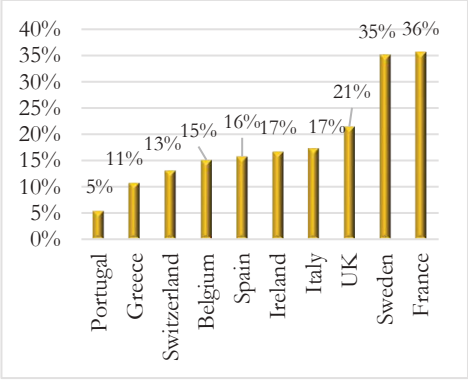

Figure 5-4: Average proportion of female directors sitting on unitary boards 2010-2015

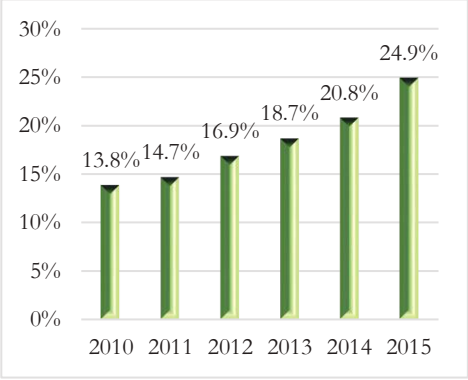

Figure 5-5: Average value of variables by country

Name	No of banks	BS	IND	Female	ROAA	NIM	Q	SR	Total Assets(Bn.)	CAPITAL	MERGER
UK	5	14.9	69%	21%	0.19%	1.36%	0.980	0%	1,361.82	13.41%	17%
Belgium	2	17.4	94%	15%	-0.05%	1.01%	0.990	0%	303.03	14.88%	0%
Ireland	3	10.6	73%	17%	-0.89%	1.29%	1.034	0%	101.49	14.04%	11%
Spain	6	14.9	49%	16%	0.16%	1.77%	0.987	0%	444.35	10.86%	44%
Sweden	4	12.2	81%	35%	0.56%	1.02%	1.518	0%	352.82	16.53%	4%
Greece	4	15.2	33%	11%	-2.03%	2.68%	0.990	-1%	82.27	11.02%	17%
France	3	17.2	45%	36%	0.24%	1.23%	0.974	0%	1,650.98	12.25%	67%
Italy	9	19.7	32%	17%	-0.15%	1.81%	0.968	0%	234.66	9.98%	9%
Portugal	3	20.4	31%	5%	-83.44%	-1.12%	0.965	0%	58.87	10.02%	6%
Switzerland	6	9.0	65%	13%	0.25%	1.10%	1.063	0%	309.74	17.34%	25%

Source: compiled by the author. The above table represents the average values of each variables from 2010-2015.

Table 5-2: Pairwise correlation matrix

		(1) ROAA	(2) NIM	(3) Q	(4) SR	(5) BS	(6) IND	(7) Female	(8) TA	(9) CAPITAL	(10) MERGER	(11) LnGI
(1)	ROAA	1										
(2)	NIM	-0.149*	1									
(3)	Q	0.130*	-0.211***	1								
(4)	SR	0.436***	-0.224***	0.161**	1							
(5)	BS	**0.0529***	**0.263***	**0.344***	0.0106	1						
(6)	IND	0.121	**0.343***	**0.355***	**0.149***	-0.407***	1					
(7)	Female	**0.156***	**0.210***	**0.393***	**0.149***	-0.104	0.216***	1				
(8)	TA	0.160*	-0.131*	-0.123*	0.146*	0.0594	0.161**	0.401***	1			
(9)	CAPITAL	0.395***	-0.316***	0.398***	0.147*	-0.310***	0.437***	0.270***	0.0879	1		
(10)	MERGER	0.120	0.119	-0.143*	0.0783	0.0606	-0.0773	0.0453	0.282***	-0.0552	1	
(11)	LnGDP	0.195**	0.0169	-0.241***	0.220***	0.307***	-0.176**	0.319***	0.539***	-0.220***	0.124*	1

*** Indicates significance at 1% level

** Indicates significance at 5% level

* Indicates significance at 10% level

Bold figures indicate the significant univariate correlations between the three main independent variables (BS, IND and Female) and the dependent variables

5.2. Correlation matrix

Table 5.2 above presents the correlation matrix for the main variables used in this study. Multicollinearity occurs when there is a strong correlation between two or more independent variables in the model. Multicollinearity reduces the statistical power of the analysis and can cause the coefficients to switch signs and makes it more difficult to specify the correct model. In general, correlation above 0.6 is considered as a high correlation, which considered as problematic to include in the model. As per the above matrix, there is no evidence of high collinearity and therefore, the model specification will not be problematic. Highest correlation is 53%, which is between total assets and the LnGDP.

The univariate correlations between board size (BS) and performance measures are significant and positively correlated except for the stock return. Percentage of independent directors are positive and significant for performance measures except for ROAA. Also, the univariate correlation for the proportion of female directors is significant and positive for all the four alternative proxies of performance.

5.3. Results of the pooled ordinary least squares (OLS)

The initial multivariate regression results using pooled OLS is presented in Table 5.3 below for all the four dependent variables. Board size is positive and statistically significant at a 1% level, supporting the H_1 that board size is positively related to bank performance. For the proportion of independent directors, the estimated coefficient is positive, and it is statistically significant when the performance is proxied by ROAA, Q and SR and consistent with the expected sign of H_3. The coefficient of the female directors is positive and statistically significant at a 1% level when performance is proxied by Tobin Q. This supports the expected sign of H_5.

Table 5-3: The effect of board structure on bank performance-Pooled OLS

	Pooled OLS			
	(1)	(2)	(3)	(4)
VARIABLES	ROAA	NIM	Q	SR
LnBS	***0.806******	***0.029******	-0.039	-0.000
	(0.153)	(0.005)	(0.028)	(0.001)
IND	**0.438***	0.009	**0.122*****	**0.002*****
	(0.227)	(0.007)	(0.038)	(0.001)
Female	0.541	0.010	**0.753*****	0.000
	(0.520)	(0.016)	(0.086)	(0.002)
TA	-0.000	-0.000	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
CAPITAL	5.933***	0.145***	0.602**	0.005
	(1.383)	(0.043)	(0.244)	(0.005)
MERGER	0.044	0.003	-0.023	0.000
	(0.133)	(0.004)	(0.022)	(0.000)
LnGDP	0.056	0.001	-0.019*	0.001***
	(0.067)	(0.002)	(0.011)	(0.000)
Constant	-4.573**	-0.112**	1.470***	-0.026***
	(1.773)	(0.055)	(0.299)	(0.006)
Observations	270	270	268	258
R-squared	0.193	0.183	0.400	0.258
Firm fixed-effects	No	No	No	No
Year dummies	Yes	Yes	Yes	Yes
F-test(p value)	0.000	0.000	0.000	0.000

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A2, Table A3 and Table A4 of the annexure describe the results of the pooled OLS regression estimated to test the H_2, H_4 and H_6 to check the nonlinear relationships between board structure variables and bank performance. When the performance is proxied by ROAA and NIM, the results are consistent with hypothesis 2(H_2) that board size has a nonlinear relationship (Table A2). The negative and significant coefficient of BS squared shows that after a certain point adding more directors will decrease bank performance. Based on the coefficient of the regressions, once the number of directors reaches 19, the bank performance starts to decrease. Similarly, when performance is proxied by ROAA and NIM the results are consistent with the hypothesis 4(H_4) that the proportion of independent directors has a nonlinear relationship (Table A3). When the proportion of independent directors are above 58%-60% for NIM and ROAA, respectively the bank performance will decrease. The negative coefficient of the female squared represents when the proportion of female directors are above 27% and 29% for NIM and ROAA, respectively and the performance started to decrease

(Table A4). Since pooled OLS is not the main estimation method, the results will not be discussed in detail. The detailed discussion is made when the results of the fixed effect estimation are presented.

As a post-regression, the diagnostic test to check the multicollinearity within the regressors after each regression, the Variance Inflation Factor (VIF) was obtained. The VIF of less than 10 is considered as the predetermined tolerance level for each independent variable. For all the pooled OLS regression models, the VIF values were less than 10 and hence it is believed that there is no evidence of multicollinearity. But it should be noted that this study did not attempt to compute VIF with the panel fixed effect estimates, as it is believed that the VIF is not a strong indicator because it ignores the correlations between the explanatory variable and dependent variable, and fixed effect models generate extremely large VIF scores (Jacobs, 2005). The next section describes the results of the main estimation method used in this study, i.e., firm fixed effects with the year dummies.

5.4. Results of the fixed effects model

Board size and bank performance

Table 5.4 below presents the results of the fixed effect estimation when performance is proxied by four different variables. As per the results of column I and II, board size has a positive and statistically significant relationship at a 1% level when the performance is proxied by ROAA and NIM. This result is consistent with the finding of the pooled OLS above. The results of the column III and IV show that there is a positive but insignificant relationship when performance is proxied by Tobin Q and stock return. The findings are consistent with the studies conducted by Adam and Mehran (2012) and O'Sullivan, Mamun and Hassan (2016) using a sample of US BHC's, where they found that the board size is positively related to performance.

The findings of this study are consistent with the argument made by Coles et al. (2008), that due to the complexity of the banks, the benefits of large boards will outweigh the costs of maintaining large boards. In a similar study, Graham, Hazarika and Narasimhan (2011) also found out that complex firms demonstrate a positive relation between board size and firm value, as complex firms benefit more from board advice. Based on the study of Adam and Mehran (2012), the main reason for the positive relationship is the value addition created by additional directors with subsidiary directorships, which facilitate the coordinating role within the larger banking group.

Table 5-4: Results of the fixed effect estimation

	Fixed Effect Estimation			
	ROAA	**NIM**	**Q**	**SR**
VARIABLES	I	II	III	IV
LnBS	**1.746*** **	**0.053*** **	0.022	0.001
	(0.259)	(0.008)	(0.029)	(0.001)
BS				
IND	**0.997** **	**0.030** **	0.002	0.002
	(0.455)	(0.014)	(0.036)	(0.002)
Female	0.421	0.012	**-0.133***	**-0.005***
	(0.905)	(0.027)	(0.070)	(0.003)
TA	0.000	0.000	0.000	0.000
	(0.001)	(0.000)	(0.000)	(0.000)
CAPITAL	5.182***	0.146***	0.333**	-0.007
	(1.867)	(0.056)	(0.151)	(0.006)
MERGER	0.022	0.002	0.008	0.000
	(0.154)	(0.005)	(0.012)	(0.001)
LnGDP	-0.246	0.002	0.291***	0.007**
	(0.913)	(0.027)	(0.070)	(0.003)
Constant	0.638	-0.223	-6.955***	-0.191**
	(24.752)	(0.742)	(1.912)	(0.079)
Observations	270	270	268	258
R-squared	0.287	0.288	0.185	0.286
Number of banks	45	45	45	45
Firm fixed-effects	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
F-Test(P value)	0.000	0.000	0.000	0.000

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Even though boards with a larger number of directors are capable of better monitoring of the management, many studies point out the problems of oversized boards. (Yermack, 1996; Eisenberg et al., 1997) The researcher was also interested in testing the nonlinear relationship between board size and bank performance as excessively larger boards create coordination, control and decision-making problems. The results represented in table 5.5 below confirmed Hypothesis 2(H_2) that there is an inverted U shape relationship between board size and bank performance when performance is proxied by ROAA and NIM. The negative coefficient in the board size squared (BS sq) proves that after a certain point adding a new director decrease

the bank performance. This finding is consistent with the study of Andres and Vallelado (2008), where the number was around 19 for a sample of 69 commercial banks from 6 OECD countries. For this sample, the number is around 27 and 28 when bank performance is proxied by ROAA and NIM, respectively. The relatively large number can be justified based on the scope of operation hypothesis presented by Boone et al. (2007). As per the above hypothesis, the board size is positively related to firm age and firm size, a finding that is complimented by the fact that the sample consists of 45 large banks in the European region wherein the majority of the banks has a history of more than 50 years.

Table 5-5: Non-linear relationship between board size and bank performance

Nonlinear relationship between board size and bank performance				
	(1)	(2)	(3)	(4)
VARIABLES	ROAA	NIM	Q	SR
BS	**0.275*** **	**0.008*** **	0.002	0.000
	(0.090)	**(0.003)**	(0.007)	(0.000)
BS sq	**-0.005***	**-0.00014***	-0.000	-0.000
	(0.003)	**(0.000)**	(0.000)	(0.000)
IND	1.112**	0.034**	-0.002	0.002
	(0.468)	(0.014)	(0.036)	(0.002)
Female	0.471	0.014	-0.131*	-0.006*
	(0.937)	(0.028)	(0.071)	(0.003)
TA	0.000	0.000	0.000	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)
CAPITAL	5.782***	0.164***	0.331**	-0.007
	(1.901)	(0.057)	(0.152)	(0.006)
MERGER	0.030	0.002	0.008	0.000
	(0.158)	(0.005)	(0.012)	(0.001)
LnGDP	-0.234	0.002	0.291***	0.007**
	(0.937)	(0.028)	(0.071)	(0.003)
Constant	1.883	-0.179	-6.915***	-0.193**
	(25.440)	(0.763)	(1.925)	(0.080)
Observations	270	270	268	258
R-squared	0.256	0.257	0.184	0.289
Number of banks	45	45	45	45
Firm fixed-effects	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
F test(P-value)	0.000	0.000	0.000	0.000

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Board independence and bank performance

As presented in Table 5.4 above, for the board independence, estimated coefficient is positive and significant when performance is proxied by ROAA and NIM. The findings are in line with the H_3 which expected a positive relationship between independent directors and bank performance. Also, findings of the study are similar to the findings of Mishra and Nielsen (2000), Anderson, et al. (2004) and Ashbauh-Skaife et al. (2006) who found that an increase in independent directors improves the earnings quality, lowers the cost of debt financing and improves the credit rating. Coles et al. (2008), using a sample of non-financial firms, found that the proportion of independent directors are positively related measures of firm complexity. Similar to the board size, higher proportions of independent directors in complex organisations have a positive effect on the performance through better monitoring and advice provided by independent directors when operating in complex business environments. Also, the result supports the argument that independent directors improve the monitoring of management, and reduce the conflict of interests between management and stakeholders, as they serve as the communication link between the firm and the external environment.

From the existing academic literature, it is clear that the independent directors are considered as better monitors of the management. But it does not mean that the board should be comprised of entirely independent directors. Therefore, it is important to achieve the appropriate mix between internal directors who are better with firm specific knowledge for the advisory roles and external directors who are better at monitoring. To identify the optimum proportion, the quadratic term of the proportion of independent directors was included in the model. As represented in table 5.6 below, there is a positive and significant relationship between the proportion of independent directors and bank performance. Moreover, there is a negative and significant relationship between the quadratic term of the proportion of independent directors. This proves that the relationship between the proportion of independent directors and bank performance is nonlinear and has an inverted U-shape. According to the coefficient of the regression model, appointing independent directors above 64% decrease the bank performance. This result is consistent with the argument made by Adam and Ferreira (2007) that external directors are better monitors of management, but an excessive proportion of independent directors will reduce the effectiveness of the advisory role of the board as it prevents executive directors with firm specific knowledge joining the board. Supporting this argument, Andres and Vallelado (2008) found an inverted U-shaped relation between the proportion of outsiders and firm performance, i.e. putting more external directors creates more firm value, but when reaching a higher proportion of external directors, Tobin Q starts to diminish. Therefore, it is important to realise that results contradict the current proposition that more independence is always better for firm performance. This finding is important for policy makers in setting corporate governance regulations regarding board composition.

Table 5-6: Non-linear relationship between proportion of independent directors and firm performance

VARIABLES	(1) ROAA	(2) NIM	(3) Q	(4) SR
LnBS	1.439***	0.044***	0.024	0.001
	(0.249)	(0.007)	(0.029)	(0.001)
IND	**11.223*** **	**0.329*** **	0.170	0.006
	(1.899)	**(0.057)**	(0.173)	(0.007)
IND sq	**-8.796*** **	**-0.257*** **	-0.146	-0.004
	(1.592)	**(0.048)**	(0.143)	(0.006)
Female	-0.368	-0.011	-0.146**	-0.005*
	(0.860)	(0.026)	(0.071)	(0.003)
TA	-0.000	-0.000	0.000	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)
CAPITAL	4.610***	0.129**	0.342**	-0.007
	(1.753)	(0.053)	(0.152)	(0.006)
MERGER	0.061	0.003	0.009	0.000
	(0.145)	(0.004)	(0.012)	(0.001)
LnGDP	-0.122	0.006	0.292***	0.007**
	(0.856)	(0.026)	(0.071)	(0.003)
Constant	-3.821	-0.353	-7.037***	-0.193**
	(23.210)	(0.698)	(1.914)	(0.079)
Observations	270	270	268	258
R-squared	0.377	0.374	0.189	0.287
Number of banks	45	45	45	45
Firm fixed-effects	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
F test(P value)	0.000	0.000	0.000	0.000

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Gender diversity and bank performance

As represented in Table 5.4 above, the proportion of female directors is statistically significant and has a negative relationship on bank performance when performance is proxied by Tobin Q and stock return. The results are contrary to H_5, which expects that female directors have a positive effect on bank performance. In the first instance when using pooled OLS, the correlation appears to be positive but when controlled for firm fixed effect to address the issue of unobserved heterogeneity the correlation reversed. This implies that the positive correlation between the proportion of female directors and bank performance in the pooled OLS regression is driven by omitted firm specific factors. The result of the study is consistent with the findings of Adam and Ferreira (2009), that female directors have an overall negative effect

on firm performance because too much board monitoring has a detrimental effect on the firm value. Also, female directors are considered to be risk averse and market may perceive appointing female directors negatively and lead to lower financial performance when the performance is measured by market-based measures such Tobin Q and stock return.

But the above findings contradict the findings of similar studies, which found that there is a positive correlation between the proportion of female directors and firm performance (Campbell & Minguez-Vera, 2008; Pathan & Faff, 2013; Farag & Mallin, 2017). They argue that gender diversity improves firm performance, consistent with the resource dependency theory and human capital theory.

To test the presence of a nonlinear relationship, the squared term of female directors was included in the model. As represented in Table 5.7, it finds that there is a U-shape relationship and appointing a female director above 34% increases the bank performance when performance is proxied by stock returns. These findings are consistent with the critical mass theory presented by Kanter (1977) that until a certain threshold of female directors are appointed to the board, abilities and the skills a female director brings to the board is undervalued. This finding supports the introduction of gender quotas that mandated the firms to appoint a certain threshold of female directors to the board. Similar to the critical mass theory, the above findings also can be linked with the social psychological theory of minority status. i.e., when women are the minority group, they do not have enough power to exert influence and inclusion of female directors does not give a positive effect. But when there is a female representation of more than 1/3 on the board, they have the power to exert influence and the firm will be able to obtain the benefit of diversity.

Table 5-7: The non-linear relationship of proportion of female directors and financial performance

VARIABLES	(1) ROAA	(2) NIM	(3) Q	(4) SR
LnBS	1.731***	0.052***	0.023	0.001
	(0.263)	(0.008)	(0.029)	(0.001)
IND	1.002**	0.030**	-0.003	0.002
	(0.456)	(0.014)	(0.036)	(0.002)
Female	1.058	0.042	-0.180	**-0.014****
	(1.965)	(0.059)	(0.152)	**(0.006)**
Female sq	-1.482	-0.068	0.109	**0.020***
	(4.059)	(0.122)	(0.314)	**(0.013)**
TA	0.000	0.000	0.000	-0.000
	(0.001)	(0.000)	(0.000)	(0.000)
CAPITAL	5.201***	0.147***	0.331**	-0.007
	(1.872)	(0.056)	(0.152)	(0.006)
MERGER	0.023	0.002	0.008	0.000
	(0.155)	(0.005)	(0.012)	(0.001)
LnGDP	-0.191	0.005	0.287***	0.006**
	(0.927)	(0.028)	(0.072)	(0.003)
Constant	-0.888	-0.293	-6.841***	-0.169**
	(25.152)	(0.754)	(1.944)	(0.080)
Observations	270	270	268	258
R-squared	0.288	0.289	0.185	0.294
Number of banks	45	45	45	45
Firm fixed-effects	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
F test(P value)	0.000	0.000	0.000	0.000

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The above findings are consistent with Lang (1986), Arrow (1998), Putnam (2007) and O'Reily et al. (1989). Also, Farag and Mallin (2017) found that in the management boards the relationship is U-shaped and appointing female directors beyond a critical mass of 27% has a positive impact on financial performance. On the contrary, using a sample of banks with unitary boards in the European region, they further find that the relationship between the proportion of female directors and firm performance is nonlinear and has an inverted U-shape, i.e., appointing above 21% of female directors decreases the firm performance.

It is believed that the use of the econometric method is the reason behind the contradictory results. The study of Farag and Mallin (2017) used a two-step system GMM to control all sources of endogeneity. Therefore, the results of this study may be biased because it did not address the econometric problem of endogeneity in full. This will be further discussed in the section on limitations of the study.

As represented in Table 5.4 above, the estimated coefficient of other control variables also has significant relationships. Tier 1 capital adequacy ratio has a statistically significant positive impact on the bank performance. It implies that well-capitalised banks perform better. This is consistent with the findings of Pathan and Faff (2013) in their study. Also, it shows that the natural logarithm of GDP has a positive and significant relationship when performance is proxied by Tobin Q and stock return, i.e., when the economy is growing, bank performance tends to be better.

5.5. Limitations of the study

The main limitation of this study is the use of the econometric method. As stated by Wintoki et al. (2012), the use of fixed effect estimation can control for one source of endogeneity, i.e., the unobserved heterogeneity. But it ignores the problem arising from reverse causality, that current values of board structure variables are a function of past performance. Ignoring reverse causality results in biased estimates and to control it the two-step system GMM need to be used, as used in other studies. Also, another limitation of this study is the use of the sample period of 6 years, which includes 270 bank-year observations. But it is recommended to use a longer sample period as governance variables do not significantly change over a small-time period and especially when testing the non-linear relationships, it is recommended to use much longer sample period. Many studies used much longer sample periods. [8]Moreover, the contribution of this study towards the formulation of policies may have been further extended by incorporating the impact of variables such as knowledge, skills and experience of BODs to bank performance, and the specific contribution of board committees to bank performance.

6. Discussion and conclusion

This study examined whether the board structure (board size, board composition and gender diversity) in banks affects financial performance by using a sample of 45 banks from 10 countries in the European region during the period from 2010 - 2015. Since the importance of corporate governance in banks came to light after the global financial crisis, it is necessary to investigate how corporate governance practices, especially board characteristics, affect the financial performance of banks. In the EU, the corporate governance regulations vary based on the national codes of corporate governance in each country. Therefore, the findings of this study can contribute to the current action plan of the European Commission in developing corporate governance practices among the EU member states.

[8] Adam and Mehran (2012) used a period of 34 years, Pathan and Faff (2013) used 14 years, and Andre and Vallelado (2008) used 10 years in their respective studies.

The study used the firm fixed effect with year dummies as the primary estimation technique to control for unobserved heterogeneity and used pooled OLS as an alternative estimation technique.

Both pooled OLS and fixed effect estimation results show that the board size is positively related to the performance, as banks benefit from a larger board due to the complexity of its operations. However, the results support the view that excessively larger boards are problematic, which shows an inverted U-shape relationship between board size and bank performance when tested for the nonlinear relationship. At the time when the number of directors reached above 19 and 28 in pooled OLS and fixed effect estimation, respectively, the bank's performance started to decrease. This finding is important to policy makers as well as individual institutions in setting up the maximum threshold for the number of directors.

Empirical evidence shows a positive relationship between the proportion of independent directors and the bank performance supporting the view that independent directors are better monitors of the banks. However, it is important to have an appropriate mix between internal directors who are better with firm specific knowledge for the advisory roles and external directors who are better at monitoring. Supporting the above view, results of the fixed effect estimation show that there is an inverted U-shape relation, and thereby, appointing independent directors above 64% will decrease the firm's performance.

Furthermore, the study found a negative relationship between the proportion of female directors and the firm's performance. This supports the argument that female directors are more risk averse than their male counterparts and too much monitoring has a detrimental effect, and hence, it affects bank financial performance negatively. But interestingly when accounting for the nonlinear relationship of the proportion of female directors, this study finds that appointing female directors above 34% increases bank performance. This finding is consistent with the view of the critical mass theory that until a certain minimum threshold is appointed to the board, the abilities and skills of the female directors are undervalued.

The findings of this study support the initial view of the researcher that the board characteristics are an important determinant affecting bank's financial performance. The findings of this study give valuable insights to the policy makers in setting corporate governance regulations. For instance, the board of directors provide monitoring and advisory roles to improve bank governance, however, beyond a certain limit, excessively larger boards will be problematic. Also, it is important to achieve the optimal combination of executive and non-executive directors, as this balance is important to create effective boards rather than excessively independent boards. Therefore, it might be important to set a maximum limit on the board size and the proportion of independent directors for the banking sector. Furthermore, the study supports various initiatives of policy makers to introduce gender quotas. Due to the interesting results of the influence of a critical mass of female directors, policy makers should take this into account when imposing gender quotas.

In conclusion, board characteristics play an important role in a bank's corporate governance mechanism. Thus, a good corporate governance system is beneficial not only to bank performance but also to the efficient functioning of the entire economic system.

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Appendices

Table -A1: Summary of academic literature

	Author & Year	Sample Period	Country	Empirical Results
Board Size and Performance	Adam and Mehran (2012)	1986-1996	35 listed Bank Holding Companies of USA	Positive
	O'Sullivan, Mamun & Hassan (2016)	1999 to 2009.	largest 150 U.S. Bank Holding Companies	Positive
	Pathan and Faff (2013)	1997-2011	212 US bank holding companies	Negative
	Liang, Xu and Jiraporn (2013)	2003 to 2010	top 50 Chinese banks	Negative
	Yermach, 1996	1984 - 1991.	452 large U.S. industrial corporations	Negative
	Eisenberg et al 1998	1992-1994	Small and midsize Finnish firms	Negative
	Hermalin and Weisbach, 2013	1971-1983	322 US listed companies	Negative
	Andres & Vallelado (2008)	1995-2005	69 large commercial banks from six OECD countries	Inverted U shape relationship
	Coles et al. (2008)	1992–2001	USA firms	Inverted U shape relationship
Board Independence and Performance	Mishra and Nielsen,2000	1990	89 US Bank Holding companies	Positive
	Anderson, etal.,2004	1993-1998	S&P 500 firms	Positive
	Andres & Vallelado (2008)	1995-2005	69 large commercial banks from six OECD countries	Inverted U shape relationship

	Author & Year	Sample Period	Country	Empirical Results
	Adam and Mehran (2012)	1986-1996	35 listed Bank Holding Companies of USA	Not related to performance
	Pathan and Faff (2013)	1997-2011	212 US bank holding companies	Negative
Gender Diversity and Performance	Adam and Ferreira (2009)	1996-2003.	S&P 500 companies	Negative
	Pathan and Faff (2013)	1997-2011	212 US bank holding companies	Improves bank performance in pre-sox period but it decreases in post-sox and crisis periods
	Carter et al. (2010)	1998-2002	S&P 500 companies	No relationship
	Campbell and Minguez-Vera (2008)	1995-2000	Listed non-financial firms in Spain	Positive relationship
	Carter et al (2003)	1995-2000	Fortune 1000 firms	Positive relationship
	Kim and Starks (2016)	2011-2013	S&P Small cap 600	Positive relationship
	Joecks, Pull and Vetter (2012)	1988-1992	The US listed companies	U-shaped relationship
	Farag and Mallin (2017)	2004-2012	99 European banks	An inverted U-shaped relationship for unitary boards and U-shaped relationship for Management boards

Source: Compiled by author

Table A2: Pooled OLS results for non-linear relationship between board size and bank performance

Non-linear relationship between Board size and Bank Performance				
	(1)	(2)	(3)	(4)
VARIABLES	ROAA	NIM	Q	SR
BS	**0.247*** **	**0.009*** **	0.003	-0.000*
	(0.049)	**(0.002)**	(0.009)	(0.000)
BS sq	**-0.006*** **	**-0.0002*** **	-0.000	0.000*
	(0.001)	(0.000)	(0.000)	(0.000)
IND	0.368	0.007	0.118***	0.002***
	(0.228)	(0.007)	(0.038)	(0.001)
Female	0.327	0.002	0.741***	0.001
	(0.523)	(0.016)	(0.086)	(0.002)
TA	-0.000*	-0.000**	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
CAPITAL	6.212***	0.156***	0.641**	0.006
	(1.383)	(0.043)	(0.247)	(0.005)
MERGER	-0.002	0.002	-0.025	0.000
	(0.134)	(0.004)	(0.022)	(0.000)
LnGDP	0.063	0.001	-0.019*	0.001***
	(0.067)	(0.002)	(0.011)	(0.000)
Constant	-4.644***	-0.115**	1.378***	-0.025***
	(1.788)	(0.055)	(0.303)	(0.006)
Observations	270	270	268	258
R-squared	0.202	0.205	0.404	0.267
Firm fixed-effects	No	No	No	No
Year dummies	Yes	Yes	Yes	Yes
F test(P value)	0.000	0.000	0.000	0.000

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A3: Pooled OLS results for non-linear relationship between independent directors and bank performance

Non-linear relation between Independent Directors and Bank Performance				
	(1)	(2)	(3)	(4)
VARIABLES	ROAA	NIM	Q	SR
BS	0.036***	0.001***	-0.003*	0.000
	(0.011)	(0.000)	(0.002)	(0.000)
IND	**3.562*** **	**0.109*** **	0.074	0.004
	(0.925)	**(0.029)**	(0.156)	(0.003)
IND sq	**-2.986*** **	**-0.095*** **	0.041	-0.001
	(0.848)	(0.027)	(0.142)	(0.003)
Female	0.861	0.020	0.743***	0.000
	(0.530)	(0.017)	(0.087)	(0.002)
TA	-0.000**	-0.000**	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
CAPITAL	5.521***	0.132***	0.602**	0.005
	(1.398)	(0.044)	(0.241)	(0.005)
MERGER	0.082	0.005	-0.024	0.000
	(0.135)	(0.004)	(0.022)	(0.000)
LnGDP	0.104	0.003	-0.019*	0.001***
	(0.067)	(0.002)	(0.011)	(0.000)
Constant	-4.874***	-0.120**	1.415***	-0.026***
	(1.816)	(0.057)	(0.303)	(0.006)
Observations	270	270	268	258
R-squared	0.181	0.157	0.403	0.259
Firm fixed-effects	No	No	No	No
Year dummies	Yes	Yes	Yes	Yes
F test(P value)	0.000	0.000	0.000	0.000

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A4: Pooled OLS results for non-linear relationship between female directors an bank performance

Non-linear relationship between female directors and bank performance				
	(1)	(2)	(3)	(4)
VARIABLES	ROAA	NIM	Q	SR
BS	0.035***	0.001***	-0.003*	0.000
	(0.011)	(0.000)	(0.002)	(0.000)
IND	0.409*	0.009	0.116***	0.002***
	(0.235)	(0.007)	(0.038)	(0.001)
Female	**3.156****	**0.105****	0.393	-0.008
	(1.539)	**(0.048)**	(0.250)	(0.005)
Female sq	**-5.425***	**-0.198****	0.755	0.018*
	(3.094)	(0.097)	(0.500)	(0.010)
TA	-0.000	-0.000*	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
CAPITAL	5.534***	0.131***	0.612**	0.005
	(1.426)	(0.045)	(0.240)	(0.005)
MERGER	0.065	0.004	-0.024	0.000
	(0.137)	(0.004)	(0.022)	(0.000)
LnGDP	0.096	0.002	-0.017	0.001***
	(0.069)	(0.002)	(0.011)	(0.000)
Constant	-4.168**	-0.097*	1.396***	-0.027***
	(1.844)	(0.058)	(0.299)	(0.006)
Observations	270	270	268	258
R-squared	0.151	0.130	0.408	0.267
Firm fixed-effects	No	No	No	No
Year dummies	Yes	Yes	Yes	Yes
F test(P value)	0.000	0.000	0.000	0.000

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

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