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# Sri Lanka's Total Factor Productivity Change during Conflict and Post-Conflict Periods

*Tharindi Gunaratna Nugawela* [1]

## Abstract

*This study analyses Sri Lanka's Total Factor Productivity (TFP) change during conflict and post-conflict periods to assess whether there has been any improvement during the post-conflict period using Solow's Residual Method (SRM)) and an index number approach (Hicks-Moorsteen Total Factor Productivity Index - HMTFPI). Findings of both approaches reveal that the TFP growth during the conflict period was higher than that of the post-conflict period. Based on the decomposition of HMTFPI into Technological Change (TC) and Efficiency Change (EC) indices, it was revealed that the main source of TFP change throughout the sample period is TC. EC had been negative throughout the sample period.*

**Key Words**: *Total factor productivity, efficiency change, technological change, Sri Lanka*

**JEL Classification:** *D24; O39; O40*

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## 1. Introduction

Productivity growth is an important aspect of economic and social development of a country. Productivity growth improves competitiveness, and is hence a required ingredient to attract foreign investments and also to boost export trade. Productivity drives the economic growth and helps realise improved living standards. Productivity is a measure of performance commonly defined as the ratio of outputs to inputs (measured in terms of volumes). Larger values of this measure are more desirable, since it is associated with better performance. Productivity is a relative concept, and it could be compared with the productivity measured during another year, or with the productivity of a different unit (firm or an economy), at the same point of time. Total Factor Productivity (TFP) is referred to as the productivity measure involving all factors of production (Coelli et al., 2005). Unlike labour productivity (or capital productivity), which considers only the labour input (or capital input), TFP is a comprehensive measure of productivity.

This paper aims to analyse the change in Sri Lanka's TFP during the conflict and post-conflict periods to assess whether there have been any improvements during the post-conflict period. In order to measure the change in TFP, two commonly used techniques in literature are used in this paper. Firstly, a production function approach involving the Cobb-Douglass type of production function (Solow's Residual Method (SRM)) is used. Secondly, an index number approach (Hicks-Moorsteen Total Factor Productivity Index) is used. These methods are the applicable tools in analysing productivity trends in an overall economy, in the absence of price data on factors of production (Coelli et al., 2005).

The next section provides a review of the theoretical framework of productivity analyses, a review of literature on productivity during conflict periods and productivity trends in Sri Lanka. Section 3 outlines the methodology. Explanations on data, variables and data sources are provided in section 4. Sections 5 and 6 present the analysis and conclusions.

## 2. Literature review

### 2.1 Theoretical framework

This study is aimed at analysing productivity trends at the aggregate economy level (as opposed to the firm level). This section reviews productivity analysis tools, focusing mainly on the aggregate economy.

Calculation of productivity as the ratio of outputs to inputs is trivial when it involves a single input and output. However, in reality there are multiple inputs and outputs which lead to the need of aggregating the inputs into a single measure before constructing productivity measures. This gives rise to the concept of TFP. The production frontier is an important concept when computing measurements of productivity that involve multiple inputs and

outputs. The production frontier represents the maximum attainable output at each level of inputs. It is the representation of the current state of technology. Firms can operate either on the frontier (efficient) or beneath the frontier (inefficient) (Coelli et al., 2005). The Cobb-Douglas form of the production function is a simple and popular form used in productivity analyses. Translog and Constant Elasticity of Substitution are some examples of other functional forms used in productivity estimation (Coelli et al., 2005).

The change in productivity of an economy consists of two mutually exclusive and exhaustive components: Technological Change (TC) and Efficiency Change (EC). TC refers to a shift in the production frontier, and EC refers to movements towards or away from the production frontier (Coelli et al., 2005). Therefore, efficiency characterises the difference between observed output and some ideal or potential output that can be generated with existing resources, at a given point of time. It is the static aspect of productivity change. TC, on the other hand characterises the dynamic aspect of productivity change, indicating improvements in production technology from one time period to another, or a shifting of the production possibility frontier.

There are four main categories of productivity analysis techniques discussed in the literature, namely: Growth Accounting techniques, Index Number techniques, Frontier Analyses approaches and State Space Modelling. The first two approaches are the tools of analysing trends in productivity, whereas the other two approaches are the tools of analysing factors affecting productivity change in its components, TC and EC. Applicability of these approaches depends on the type of the analysis, for example, time series, cross-sectional or panel data. Further, these methods can also be grouped as parametric or non-parametric approaches. These techniques are not stand-alone techniques.

## 2.2 Trends in TFP growth during conflict periods

Literature on TFP growth during conflict periods reveal mixed results. Field (2008) has found that based on private non-farm data, post-Second World War TFP in the United States has increased at a slower rate than during the war and pre-war periods. A study by Smolny (2000) reveals that there has been a rapid productivity growth in European countries and Japan during the early post-war period of 1947-1950 on average. Nevertheless, there have been significant differences in the speed of productivity growth among the industrialised countries of the sample. There has been a rapid economic and productivity growth in West Germany after the Second Wald War (Eichengreen and Ritschl , 2009), due to fast convergence to the potential output resulting from the structural changes introduced and the rigorous regulations imposed. Comin and Hobjin (2001) studied the post and pre-second world war growth trajectories of a sample of countries. It was revealed that the war effect moved up to a higher growth path than they were on, before the war. This boost in growth was mainly driven by growth in TFP, which was accompanied by the increases in technology. The postwar European history analysis by Stone (2008) discusses the TFP growth differences between the

Western and the Eastern European countries and the Soviet Union. He argues that the TFP growth acceleration in the Western Europe was due to the high level of technological adoption, whereas the slow TFP growth in the Eastern Europe and the Soviet Union was due to low incentives for innovation at the firm level even though investment expenditure incurred was high. Studies on TFP change during conflict periods focus mainly on the growth in TFP itself. Literature on extensive analysis of sources of TFP change during conflict periods is rare to find.

Literature on Sri Lanka's TFP change are mainly focused towards analyzing the trends in specific industries. For example, Thayaparan and Pratheepan (2014) study the change in TFP in the banking industry. Dutz and O'Connell(2013) analyse the impact of key business environment indicators on productivity, innovation, and growth in Sri Lanka using data of the 2004 and 2011 World Bank Enterprise Surveys. Duma (2007) analyses the sources of economic growth using the growth accounting framework, which however, does not cover the post-conflict period. This study is focused on analysing and comparing the trends in TFP during the conflict and post-conflict periods in Sri Lanka, as little or no effort has been directed towards analysing post-conflict TFP trends.

The objective of this study is to analyse whether there has been any improvement in TFP growth during the post-conflict period, compared to the conflict period in Sri Lanka and what sources of productivity were prominent during the conflict and post-conflict periods.

During a conflict period, the process of efficient allocation of resources and also the innovation process are disturbed, leading to a decline in productivity. Based on the findings of Comin and Hobjin (2001), the first hypothesis is formed:

H1: There has been an improvement in TFP growth in Sri Lanka during the post-conflict period, compared to the conflict period.

Commonly, developing countries, or countries with resource barriers improve productivity mainly through efficient allocation of existing resources. In developing economies, where technological progress takes more time, the prominent source of productivity change could be efficiency change (Headey et al., 2010). It is hypothesised that during the conflict period, the main source of TFP change was efficiency change, and during the post-conflict period, the main source of TFP change was technological progress.

H2: The main source of TFP change during the conflict period was efficiency change and the main source of TFP change during the post-conflict period was technological progress.

## 3.  Methodology

### 3.1 Solow's residual

The pioneering idea of the growth accounting method of productivity measurement comes from Solow's work, popularly known as the Solow Residual (Solow, 1957). Solow's famous article shed light on measuring technological change with respect to the production function of an economy. The central idea of the Solow Residual is based on a standard Neo Classical production function of output $(Y_t = A_t f(K_t, L_t))$ and decomposition of the growth in output at time t, $(\frac{\Delta Y_t}{Y_{t-1}})$ in to the weighted average of the growth of the two inputs Capital and Labour (the weights are considered as relative shares of Capital and Labour), and the growth in Total Factor Productivity (TFP). Hence, the decomposition of a Neo-Classical production function, with Cobb-Douglas form $(Y_t = A_t K_t^\alpha L_t^{1-\alpha})$ can be expressed as:

$$\frac{\Delta Y_t}{Y_{t-1}} = \alpha \frac{\Delta K_t}{K_{t-1}} + (1 - \alpha) \frac{\Delta L_t}{L_{t-1}} + \frac{\Delta A_t}{A_{t-1}} \tag{1}$$

Where $K_t$ and $L_t$ denote capital and labour available at time period t, $\alpha$ is the output share of capital and $\frac{\Delta A_t}{A_{t-1}}$ is considered as the growth in TFP at time t.

Equation (1) can be re-written as:

$$Growth\ in\ TFP = \frac{\Delta Y_t}{Y_{t-1}} - \alpha \frac{\Delta K_t}{K_{t-1}} - (1 - \alpha) \frac{\Delta L_t}{L_{t-1}} \tag{2}$$

The main assumptions of Solow's method are (Oecd, 2001):

- The production technology can be represented by a production function relating gross output to inputs, which exhibits constant returns to scale.

- Productivity changes are Hicks-neutral, where, for a given capital to labour ratio, the ratio of marginal product of capital to marginal product of labour remains unchanged.

- Factor input markets are competitive.

The assumption of constant returns to scale implies that the only source of productivity change is due to TC. This gives rise to an issue of measuring productivity change in developing economies. In such countries TC is a long run phenomenon and the prominent source of productivity change could be EC (Headey, Alauddin, & Prasada Raob, 2010).

### 3.2 Index number approaches

### 3.2.1 Input and output distance functions

Index number approaches of productivity measurements are commonly based on the concept of distance functions (Coelli, Prasada Rao, O'Donnell, & Battese, 2005). Distance functions were first introduced by Malmquist (1953) and gained attention in efficiency and productivity analysis with the introduction of the Malmquist index number approach by Caves et al. (1982). The idea of an input (or output) distance function is, measuring the radial contractions (or expansions) of a production point at which the firm operates with respect to the point on the production frontier (or the isoquant). It allows describing technology while measuring efficiency and productivity, without the need of defining an objective such as cost minimisation or profit maximisation. Input distance functions are given as the minimal proportional contraction of the inputs given the outputs, for a given production technology. Output distance functions are given by the maximal proportion expansion of outputs given inputs and the production technology (Coelli et al., 2005).

The distance function is defined for the production possibility set $\Omega$ at time t,

where, $\Omega = \{(x, y)|\ x\ can\ produce\ y\}$

and x is an input vector and y is an output vector.

The distance function is defined by rescaling the length of an output (output distance function) or an input (input distance function) vector, using the production possibility function as a reference.

$$D_O^t(x, y) = min\{\delta|\left(\tfrac{y}{\delta}\right) \in\ \Omega\} \tag{3}$$

$D_O^t(x, y)$ is non-decreasing and convex in y and non-increasing, linearly homogeneous and quasi-convex in x. If $D_O^t(x, y) > 1,$ y is not producible by x. If $D_O^t(x, y) \leq 1,$ $D_O^t(x, y)$ measures the (in)efficiency. If $D_O^t(x, y) = 1,$ it indicates full efficiency, where more outputs cannot be produced without increasing the inputs (Coelli et al., 2005). Figure 1 illustrates the concept of the distance function.

**Figure 1: Output oriented distance function**
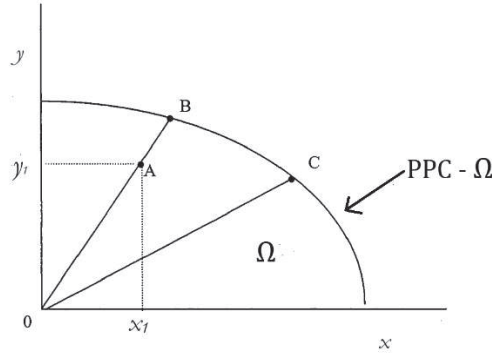


Source: Coelli et al. (2005)

Here the economy uses input x and produces output y. The production possibility set $\Omega$ is the area bounded by the production possibility frontier, PPC- $\Omega$ and x and y axes. If the firm is using input level $x_1$ to produce $y_1$, defined by the point A, the value of the distance function $D_0^t(x_1, y_1)$ is equal to the ratio $\delta = 0A/OB$ (Coelli et al., 2005).

### 3.2.2 Malmquist index and its variants

The Malmquist index number approach (Caves, Christensen, & Diewert, 1982), became more popular in recent literature, due to its flexibility. Caves et al. re-introduced the index number method first introduced by (Malmquist, 1953), which involves computations with the use of input or output distance functions. Unlike the Solow residual, which is restricted to constant returns to scale, the Malmquist productivity index has the flexibility of variable returns to scale production technologies. Due to its flexibility, the Malmquist index is widely used in firm level and industry level studies. Färe, Grosskopf, Norris, and Zhang (1994), Taskin and Zaim (1997) and Maudos, Pastor, and Serrano (1999) apply the Malmquist index in country level studies.

The Malmquist productivity index for two observed input–output vectors ($x_t$, $y_t$) and ($x_{t+1}$, $y_{t+1}$) at time points, t and t+1, can be defined with the use of output distance functions (alternatively, with input distance functions) as in equation (4) (Coelli et al., 2005). The maximum proportional expansion is measured by the output distance function (alternatively the minimal proportional contraction measured by the input distance function) which is evaluated at state of prevailing technology.

$$M_o(y_{t+1}, y_t, x_{t+1}, x_t) = \left( \frac{D_0^t(y_{t+1}, x_t)}{D_0^t(y_t, x_t)} \times \frac{D_0^{t+1}(y_{t+1}, x_{t+1})}{D_0^{t+1}(y_{t+1}, x_t)} \right)^{1/2} \qquad (4)$$

Where $D_0^s(q_t, x_t)$ is the output distance from observation of period t, computed using technology of period s as the reference technology.

If the index value is greater than 1, it indicates an improvement in TFP, while a value less than 1, indicates deterioration in TFP.

### 3.2.3 Hicks-Moorsteen index

Although the Malmquist index appears to be very popular, it suffers from a number of theoretical deficiencies (O'Donnell (2010), Kerstens and Van de Woestyne (2014) and Peyrache (2013)). The Malmquist index fails to decompose TFP into its sources, as it does not satisfy axioms of index number theory, which allow such decomposition. Indices that are suitable for such decompositions should be multiplicatively complete.

To overcome this deficiency in the Malmquist index, Hicks-Moorsteen Total Factor Productivity Index (HMTFPI) is used. It can be defined as the ratio of growth in outputs to growth in inputs (Diewert, 1992), where growth in outputs and inputs are measured through index numbers.

$$HMTFPI = \frac{Growth\ in\ Outputs}{Growth\ in\ Inputs} \qquad (5)$$

Bjurek (1996) re-introduced a modified approach of calculating the existing Hicks-Moorsteen Total Factor Productivity Index (HMTFPI) as a ratio of Malmquist output and input indices.

$$HMTFPI = \frac{Malmquist\ Output\ Index}{Malmquist\ Input\ Index} \qquad (6)$$

Once growth in inputs and outputs are measured through an appropriate index (among any available indices), measuring change in productivity through HMTFPI is easy, and it also provides the source of change (whether it is technological change or efficiency change) (Nemoto and Goto, 2008). Accordingly, the decomposition of HMTFPI in to TC and EC component indices can be presented as:

$$HMTFPI = \frac{M_o(y_t, y_{t+1}, x_t, x_t)}{M_I(y_t, y_{t+1}, x_t, x_t)} = \left( \frac{D_0^t(y_{t+1}, x_{t+1})}{D_0^{t+1}(y_{t+1}, x_{t+1})} \times \frac{D_0^t(y_t, x_t)}{D_0^{t+1}(y_t, y_t)} \right)^{\frac{1}{2}} \times \left( \frac{D_0^{t+1}(y_{t+1}, x_{t+1})}{D_0^t(y_t, x_t)} \right)$$

$$(7)$$

$$\text{where, } TC = \left( \frac{D_0^t(y_{t+1}, x_{t+1})}{D_0^{t+1}(y_{t+1}, x_{t+1})} \times \frac{D_0^t(y_t, x_t)}{D_0^{t+1}(y_t, y_t)} \right)^{1/2} \text{ and}$$

$$EC = \left( \frac{D_0^{t+1}(y_{t+1}, x_{t+1})}{D_0^t(y_t, x_t)} \right)$$

A value of a component index greater than 1 indicates improvement, while a value less than 1 indicates deterioration of the conditions.

Further, in the absence of panel data, the HMTFPI is preferred over the Malmquist index, as the Malmquist approach uses the concept of cone technology, which requires a dataset large enough to provide a good description of the underlying technology (Coelli et al., 2005)).

In this study, DPIN (Decomposition of Productivity Index Numbers) software (O'Donnell, 2011) has been used to compute the HMTFPI and its components.

## 4. Data

The real Gross Domestic Product (GDP) series with the base year as 2002, published by the Department of Census and Statistics (DCS) was used, as it contains data covering both the conflict and post-conflict periods. The GDP (2010=100) series covers only the post-conflict period. Annual data starting 2002 to 2014 was used for the analysis. Quarterly data could not be used due to inconsistencies in the frequency of available employment data (data for some quarters during the sample period are not available) and the unavailability of a quarterly series of gross capital formation.

The total number of hours worked (Total number employed × Average number of hours worked per person) was used as the labour input. The average number of hours worked per person is taken from the Penn World Tables (PWT) Version 9.0 (Feenstra et al.,2015). The official statistics series of Sri Lankan Labour Force published by the DCS has a few inconsistencies regarding the coverage of data during several years, due to the inability of conducting the Labour Force Survey in areas where the conflict was happening. In order to correct the discrepancy, a correction on the number employed variable of the DCS series was applied using growth in the employment variable of PWT database as the growth rates of the DCS series and the PWT series move closely for the years that DCS data are complete. Therefore, the growth rate of the PWT series for the years 2002 to 2011 is applied to re-estimate the employment data series for the period from 2002 to 2011 (see Appendix A.1 for details).

In order to estimate the capital stock, the Perpetual Inventory Method (PIM) employing 6% depreciation (Iyer et al., 2008) was used employing gross capital formation data series for Sri Lanka, which is available in the World Bank Database (Appendix A.2).

The output's share of labour ([α -1] of the Cobb-Douglas production function) is taken as the long-run average (2000-2015) of the labour share of output variable of the PWT database (Appendix A.3).

When determining the sample period for the study, data limitations had to be considered. The GDP series (2002=100) covers the period from 2002 to 2015. The labour force data series of DCS does not cover the entire island for the period from 1990-2010 (Appendix AII). The conflict began in the early 1980s and ended in 2009. Based on data availability, this study analyses the TFP change during the period from 2003-2009 (conflict period) and from 2010-2015 (post-conflict period).

## 5. Analysis

### 5.1 The change in total factor productivity based on Growth Accounting Framework

SRM analysis of TFP change reveals that the average conflict period TFP growth (3.24 %) is greater than the post-conflict period TFP growth (1.98%) in Sri Lanka. The highest TFP growth of 5.96% during the sample period is recorded for the year 2008, when the conflict was at its highest level, before the war ended in 2009.The lowest TFP growth for the sample period is recorded for the year 2013, which is a TFP regress of -0.74%. Since SRM TFP change accounts only for the Technological Change (TC) aspect of TFP change, findings reveal that irrespective of the conflict situation during the conflict period, a higher level of positive TC has happened. The TFP growth dynamics can be further explained by a more disaggregated level TFP analysis of TFP components, EC and TC, through the index number approach.

**Figure 2: Change in TFP during 2003-2015 period based on the Solow's residual**
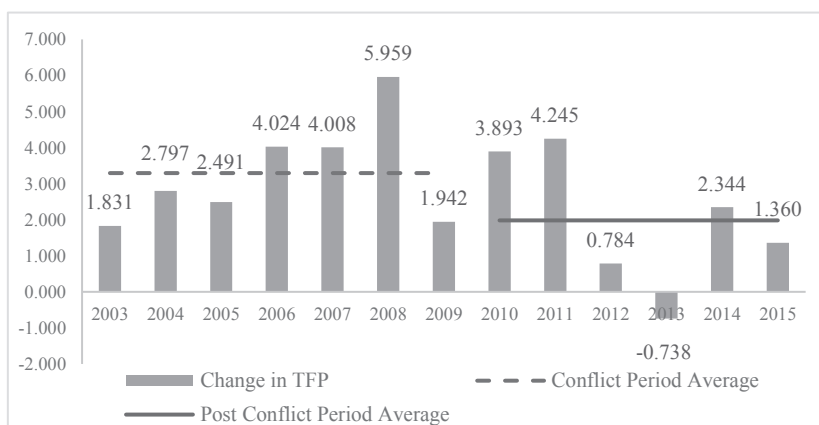


Source: Author's calculations

## 5.2 TFP change based on the index number approach

Overall TFP change as per the HMTFPI values also indicate that the average TFP growth during the conflict period is greater than the post-conflict period TFP growth. The average TFP index during the conflict period is 1.0242, while the same during the post-conflict period is 1.0159.

Throughout the period, TC has been positive, except for the year 2012. Average TC during the conflict period (1.043) is greater than that during the post-conflict period (1.034), which is consistent with the SRM findings.

The TFP change during the sample period is entirely due to positive TC, as the EC has been negative or neutral for the entire period. The negative EC has pushed the overall TFP growth down. Furthermore, the EC decline during the post-conflict period (average index value is 0.983) is minutely higher than the same during the conflict period (average index value is 0.982).

The highest TFP change is observed during the year 2008 (consistent with the SRM findings). The lowest TFP change (negative change) is observed in 2012 (inconsistent with SRM findings).

**Figure 3: Change in TFP during 2003-2015 period based on the HMTFPI**



Source: Author's calculations

**Figure 4: Technological Change during 2003-2015 Period based on the HMTFPI**
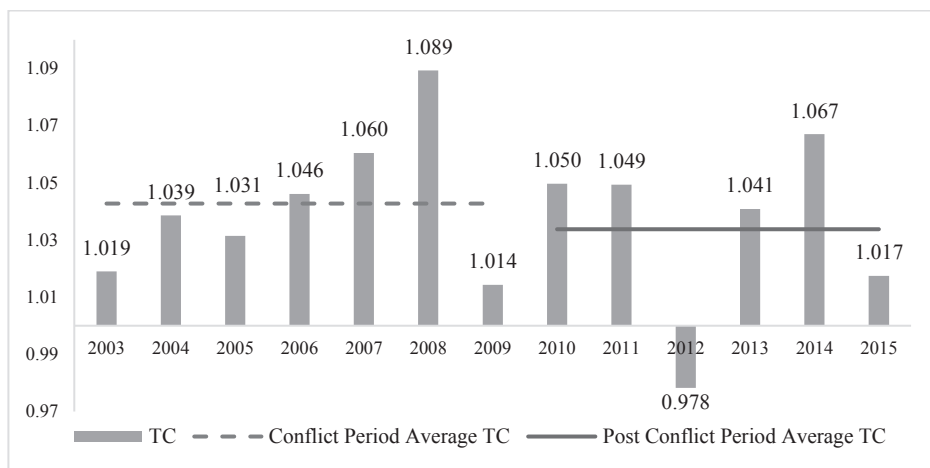


Source: Author's calculations

**Figure 5: Efficiency Change during 2003-2015 Period based on the HMTFPI**
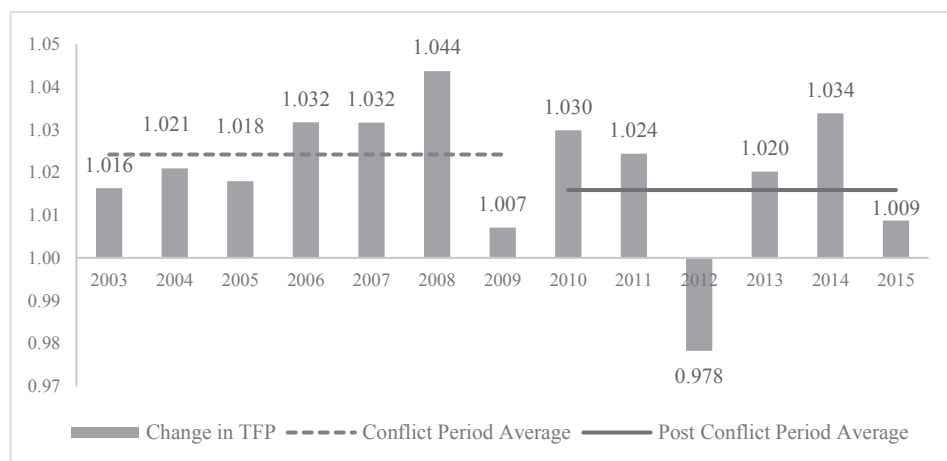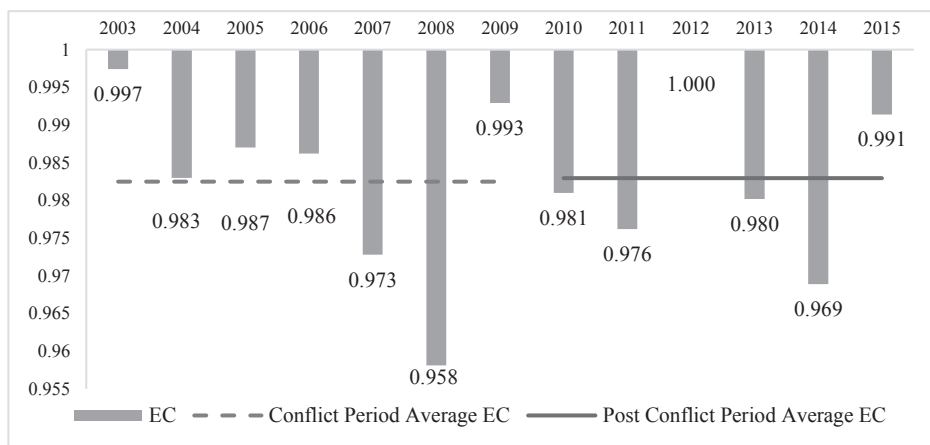


Source: Author's calculations

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The TFP change during the sample period is entirely due to positive TC, as the EC has been negative or neutral for the entire period. The negative EC has pushed the overall TFP growth down. Furthermore, the EC decline during the post-conflict period (average index value is 0.983) is minutely higher than that during the conflict period (average index value is 0.982).

The highest TFP change is observed during the year 2008 (consistent with the SRM findings). The lowest TFP change (negative change) is observed for 2012 (inconsistent with SRM findings).

**Table 1: Average TFP. TC and EC during conflict and post-conflict periods**

| Method | Average Change | |
|---|---|---|
| | Conflict Period | Post-Conflict Period |
| Solow's Residual | | |
|     TFP Change | 3.293 | 1.981 |
| HMTFPI | | |
|     Technological Change | 1.043 | 1.034 |
|     Efficiency Change | 0.982 | 0.983 |
|     TFP Change | 1.0242 | 1.0159 |

## 6. Conclusions

This study was carried out to investigate TFP growth trends in the Sri Lankan economy with respect to the conflict and post-conflict periods. The analysis was carried out with two approaches, the SRM and the HMTFPI.

Assuming that during a conflict period, the process of efficient allocation of resources and also the innovation process are disturbed, leading to a decline in productivity, the first hypothesis was formed. The first hypothesis (H1) stated that there has been an improvement in TFP during the post-conflict period, compared to the conflict period. Based on the findings of both approaches, H1 was rejected where it was revealed that the TFP growth during the conflict period was higher than that during the post-conflict period.

The second hypothesis was formulated with the aim of understanding what sources of productivity were prominent during the conflict and post-conflict periods. It was hypothesized that the main source of TFP change during the conflict period was efficiency change and the main source of TFP

change during the post-conflict period was the technological progress (H2). H2 cannot be assessed through SRM as it assumes the TFP change of the economy was solely due to TC. Based on the HMTFPI, H2 was rejected, as it revealed that the main source of TFP change throughout the sample period is TC, and EC had been negative throughout the sample period.

Positive EC is imperative for a developing country, particularly, if the growth momentum is expected to be bolstered through foreign investments. Negative EC deters investors. Attention should be drawn towards increase in efficiency though effective resource allocation and minimizing wasteful inputs.

Even though TC is the sole contributor towards TFP growth in the economy during the sample period, post-conflict TC has decelerated compared to that of the conflict period average, which could be due to the increased focus on low yielding infrastructure development projects and new investment projects started in the post-conflict period. Out of the total nominal gross domestic capital formation (investment), 38.4% was used for government infrastructure development projects during the post-conflict period, while that during the conflict period was 22.3% (Central Bank of Sri Lanka, 2015, 2014 and 2011). Stone (2008) argues that high a level of investment spending on infrastructure development alone is inadequate for post-conflict TFP to grow. Firm level efforts on improving technology and efficiency are also required. However, to support such firm level efforts, institutional continuity and the absence of radical changes in policy are required (Eichengreen and Ritschl, 2009).

Both approaches revealed that there has been a rapid TFP growth during the early post-conflict period (in 2010 and 2011). This is consistent with the findings of Smolny (2000) and Eichengreen & Ritschl (2009), where countries experienced rapid TFP growth during the early post-Second World War period.

The increase in the labour input during the conflict period was 1.13% compared to a 2.27% increase during the post-conflict period. The growth in real capital formation (growth in real gross domestic capital formation) during the conflict period was 9 %, while that for the post-conflict period is 10%. Meanwhile, the average economic growth during the conflict period was 5.9%, while that during the post-conflict period was 6.4%.

Irrespective of the higher level of increase in both the inputs and the outputs during the post-conflict period, the TC during the conflict period has been higher. In spite of the higher level of inputs generating higher level of outputs during the post-conflict period, the economy during the conflict period has enjoyed higher TFP growth with relatively low negative EC (relatively low inefficiency) and relatively high positive TC. This implies that the quality of capital and labour inputs used during the conflict period could have been higher than that of the post-conflict period. Quality of labour force comes through the knowledge, skill, experience and expertise level of individuals. Quality of capital inputs can be sourced through the use of high-tech equipment, and innovation through research and development.

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## Appendices

### A.1 Correcting the discrepancies in the employment data series

Sri Lanka's labour force data series published by the Department of Census and Statistics (DCS) contains a few discrepancies due to the inadequate coverage caused by the problems of conducting the Labour Force Survey during the conflict period in conflict affected areas. As such, data from 2002 to 2011 does not cover the entire island.

**Table A1: Coverage of the Quarterly Labour Force Survey (QLFS) of the DCS (1990-2015)**

| Period | Coverage |
|---|---|
| 1990-2002 | Data excluding both Northern and Eastern provinces. |
| 2003 | Data excluding the Northern Province. |
| 2004 | Data excluding both Mullaitivu and Killinochchi districts |
| 2005 | Data covers the entire island. QLFS was conducted as a one-off survey in August 2005. |
| 2006-2007 | Data excluding both Northern and Eastern provinces. |
| 2008-2010 | Data excluding the Northern Province. |
| 2011-2015 | Data covers the entire island. |

Source: DCS

In order to correct the discrepancy, a correction on the number employed variable of the DCS series was done using growth in the employment variable of PWT database. The growth rates of the DCS series and the PWT series move closely for the years that data are complete. Therefore, the growth rate of the PWT series for the years 2002 to 2011 is applied to re-estimate the employment data series for the period from 2002 to 2011.

**Figure A1: Growth in employment**
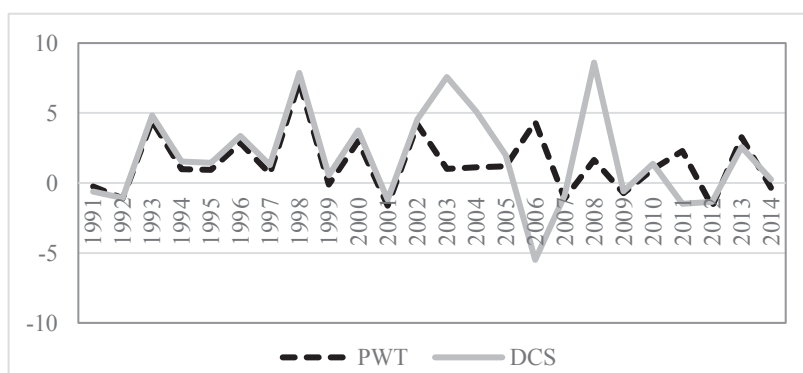


Sources: PWTDCS and author's calculations

**Table A2: Re-constructed employment data series**

| Year | DCS Number Employed Series | Growth in the Number Employed as per PWT | Re constructed Series |
|------|------|------|------|
| 2001 | 6,236 | | |
| 2002 | 6,519 | 4.180 | 6,496 |
| 2003 | 7,013 | 1.017 | 6,562 |
| 2004 | 7,394 | 1.114 | 6,635 |
| 2005 | 7,518 | 1.188 | 6,714 |
| 2006 | 7,105 | 4.372 | 7,008 |
| 2007 | 7,042 | -1.131 | 6,928 |
| 2008 | 7,648 | 1.645 | 7,042 |
| 2009 | 7,602 | -0.721 | 6,992 |
| 2010 | 7,707 | 0.974 | 7,060 |
| 2011 | 7,592 | 2.297 | 7,222 |
| 2012 | 7,489 | | 7,489 |
| 2013 | 7,681 | | 7,681 |
| 2014 | 7,700 | | 7,700 |
| 2015 | 7,831 | | 7,831 |

Sources: PWT, DCS and author's calculations
Note: Highlighted numbers are calculated based on PWT growth rates

## A.2 Perpetual inventory method of estimating capital stock

The method used to estimate the capital stock is the Perpetual Inventory Method (PIM). Following Iyer et al. (2008), the following equation was used to estimate annual capital stock for each country using gross domestic capital formation data.

$$K_t = (1 - d)K_{t-1} + I_t$$

Where K is the capital stock, I is the investment (Gross capital formation), and d is the depreciation rate, which is assumed to be 6% following Iyer et al. (2008). The initial capital stocks were estimated based on the assumption that capital and output grow at the same rate. The initial capital stock was calculated for the year 1970 with;

$$K_{1970} = \frac{I_{1970}}{(g + d)}$$

Where g is the average growth rate of output calculated for the period between 1961 and 1970.

**A.3 Obtaining the long run average of the labour share of output using the Penn World Tables labour share of output series for Sri Lanka**

As per the PWT series of Labour Share of Output (LSO), there are three main eras. The first period is from 1961-1987, where LSO remained almost constant around 0.79. The second period is from 1988-1999, where LSO declined drastically. The third period is from 2000-2015, where LSO oscillated around 0.69. The long run LSO for the sample period is considered as 0.69, which is   (1-α ) for the analysis.

**Figure A2: Labour share of output**
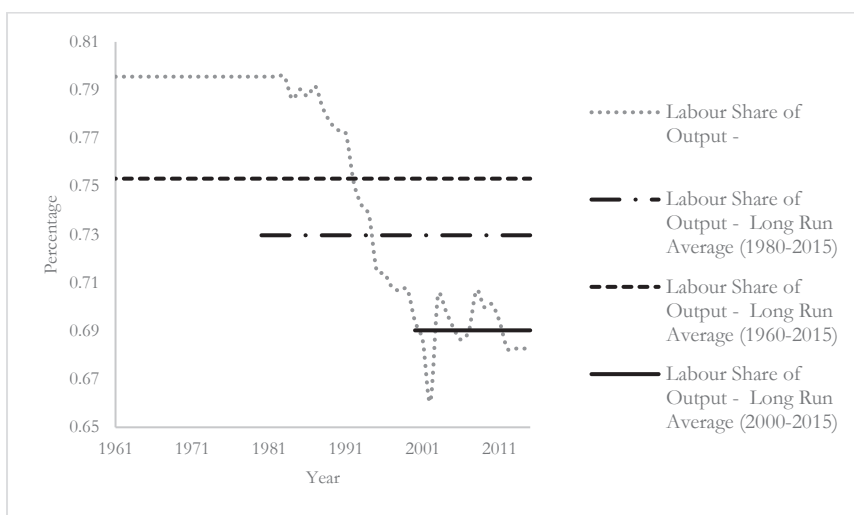


Sources: PWT and author's calculations

# Effect of Government Bailouts on the Bank Performance and Risk Taking within Bailed out Banks

*Thilini N. Jayasinghe* [1]

## Abstract

*During the global financial crisis, several banks all over the world were distressed due to the negative effects of the crisis. In order to mitigate the systemic risk, governments were under severe pressure to intervene in the financial industry in the form of government bailouts. However, these massive government bailout programmes created the debate whether the aftermath effects are positive or negative to the financial system. This paper focuses on finding the effects of government bailouts on the bailed out banks in terms of performance and risk taking during the post bailout period. It is found that government bailout has a significant negative impact on performance, while there is a significant positive relationship between bailout capital and the bank risk taking during the post bailout period.*

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## 1.    Introduction

When considering the global context, the sub-prime mortgage crisis, which evolved in the US in 2007, severely affected the financial system stability around the globe, notably in the European region. The downturn in the financial sectors of the US, UK and Europe severely affected financial systems of international scale all over the world and led the global financial crisis. Due to the unrivalled scale of this crisis the real global economy was severely damaged, making large losses since the great depression. There was a dramatic decline in the value of assets including real estate and commodity prices, caused by the collapse of a number of large banks and other financial institutions, increasing the level of unemployment. The situation led governments all over the world to seek for ways and means to drive their countries out of the crisis (Moshirian, 2011).

When the global financial crisis aggravated, several banks all over the world ran down, creating a negative outlook on the global economy, where the governments were attempting to rescue their banks and other affected sectors of the economies. Many governments offered bailout packages including asset protection schemes, asset backed security schemes as well as corporate guarantees to the depositors of distressed institutions as a way of fighting back a systemic crisis. Nationalisation programmes were conducted as a response to the crisis, where governments bought partial or full ownership of some banks and financial institutions. Further, governments introduced prudential regulations for the financial industry, demanding a pro-active role from central banks as the financial sector regulator (Moshirian, 2011).

Financial crises have a significant negative effect on growth, irrespective of the fact that the financial system is developed or not (Kroszner et al., 2007). Banks and other financial institutions are the main financial intermediaries within a financial system that allow credit creation. When there's a failure in these intermediaries, where the presence of such intermediaries is important, there will be a contractionary impact on the whole financial system due to its high reliance (Kroszner et al., 2007). In order to overcome the negative effects, there were massive scale government interventions with large volume of government support in terms of capital being flowed in to the distressed banks (Hryckiewicz, 2014). However, the massive scale government bailouts created the debate whether they will serve the purpose of dramatic recovery in the financial sector or create further problems to the financial system stability of a country. In that sense, studying the effects of government interventions in the bailed-out banks will have macro-economic importance.

## 2. Literature review

### 2.1 Government intervention in the banking industry

The subprime mortgage crisis that started in the US, was a catalyst for the systemic financial crisis that provoked in several countries around the globe, including the UK as well as the European Union. The severe effects on the domestic financial systems required the national governments, intervention and rescue of fleets of entities to reduce the aftermath effects of systemic crises. The main focus was on the financial sector, where a large number of distressed banks had to be rescued by national governments implementing several strategies, to secure the financial system stability.

According to Fahri and Tirole (2012), the mechanism of bailout is divided into two main strategies,

1.  Focusing on the entire financial system, systemic remedies offered to all institutions disregarding level of effect on the crisis, which can be policy measures such as interest rate management.

2.  Individual policy measures aiming at a particular bank or financial institution severely affected by the crisis, by deploying a significant amount of state resources such as tax revenue.

When looking at how banks have been bailed out by governments, there are several types of bailout instruments that are used based on the severity of the crisis. These instruments can be categorised as; credit guarantee schemes at the initial stages of the crisis, when the confidence on the banking system is uncertain. Then, the capital injections in the form of special liquidity schemes were used at the peak, where there are bank runs as explained in Diamond and Dybvig (1983). Special liquidity schemes are important in order to avoid the contagion effect while increasing the confidence towards the banking system, avoiding the crisis spreading to other healthy institutions, reducing value of the whole banking system. Asset protection schemes and asset backed security schemes are used at the final stages of the crisis as remedial measures (Pazarbasioglu et al., 2011; NAO, 2010). When the government does not have enough liquidity to bail out a bank through capital injections, it will be optimal to use a government assisted merger or acquisition (Acharya & Yorulmazer, 2007). Hryckiewicz, (2014) identified that the most common type of bailout measure in the recent financial turmoil was nationalisation through capital injections, where the ownership was transferred to the government. During the recent history, most banks that were nationalised were systemically important global banks. Further, in asset protection schemes, the government will secure the bad debt up to the value of asset decreased, allowing the bank to recapitalise itself for survival. For this strategy to be successful, market discipline should be in place, as the government will not participate in bank operations (Ratnovski et al., 2012).

### 2.2 Government policy implications relating to interventions

Government safety net is an important factor for the financial system stability of a country. The importance of government safety net was highlighted during the outbreak of the recent financial crisis where several governments were acting as lenders of last resort, implementing bailout policies to secure the financial systems of the countries. According to Gorton and Metrick (2013), in order to mitigate the risk of a liquidity driven crisis in the financial system, two pillars, being lender of last resort and deposit insurance have been implemented. The incentives for the banks may shift with the expectation of the functioning of the government safety net, where the banks can take higher risk seeking strategy for a higher return. This implication leads to the rationale of close supervision and regulation, which limits leverage and risk taking of the financial institutions.

Central Banks play a vital role in financial regulation particularly in the government safety net, while providing the lender of the last resort facility through the provisioning of contingent liquidity to the banks. Under the perfect market conditions, depositor's expectation in a systemic crisis will be that the Central Banks would lend freely to safeguard the problem institutions while letting the institutions fail outside of crisis, where there are incentives for a bank run. In order to establish the credibility within the financial system, avoiding systemic failures is an important implication for a Central Bank on behalf of a government (Dooley, 2014; Gorton and Metrick, 2013; Lacker, 2014).

Gorton and Metrick (2013) further highlights two dynamic and complex implications of the government safety net, as if the safety net is too large, then the banks will lose the incentive of managing the risk, which in turn leads to moral hazard behaviour. On the other hand, if the safety net is too small, possible failures of larger banks may systemically create a threat to the financial system as a whole, due to the spill over effect. Considering the fact, if larger banks and larger financial institutions are to be given complete protection, then there will be motivation in the industry for every financial institution to be grown into a 'too-big-to-fail' financial institution, which has to be safe guarded by the governments during a crisis, even at a very high cost (Barth & Schnabel, 2013). Demirgüç-Kunt and Huizinga (2013) however realise that due to the deterioration of public financing, the ability to bailout the too-big-to-fail is questionable around the world, especially in countries running with larger deficits and fiscal imbalances. Further, they argue that it is vital for regulatory measures such as downsizing or splitting up to be systemically important banks, as the value of such banks can be improved while reducing the risk of converting in to too-big-to-fail.

Moreover, according to Acharya and Yorulmazer (2007) 'too-many-to-fail-effect' exists in the regulation context. Too many to fail effect has been defined by Allen and Gale (2000) cited in Brown and Dinç (2011) as "Regulators may choose not to take over or close a failing bank if there are many weak banks. Alternatively, there may be reasons for aggressive regulatory intervention in failing banks when the banking system is weak, precisely because of concerns

about systemic risk". Brown and Dinç (2011) found that this argument is robust even after several macroeconomic and crisis related factors such as too-big-to-fail effect and systemic risk are being controlled. Discussed policy implications will always affect the severity of government decision making regarding the intervention in the banking industry as a whole.

## 2.3 Government bailouts and practical implications

Government bailout in the banking industry is conducted with the objective of restoring market confidence and preventing the happening of a systemic banking crisis (Mehran & Thakor, 2011). However, the bailout policies can sometimes end up in moral hazard behaviour of the banks due to the classic problem of information asymmetry (Yiannaki, 2011). There are several practical implications relating to the process of government intervention in the banking industry. "Too-big-to-fail rule vs too-many-to-fail rule" is one of the most important implications. The too-big-to-fail problem will affect the large banks, while the too-many-to-fail effect will have significant implications on the smaller banks. This is where, at the failure of one bank, there will be several other banks, which will face difficulties in an economy (Yiannaki, 2011). Although, the main objective of bailout is stability, it will not always be achieved, as the governments will favour underperforming entities by safeguarding their assets at a high social cost in the long term.

## 2.4 Government bailouts and bank behaviour

Theoretically, government intervention in the banking industry should reflect desired outcomes, such as the confidence in the banking sector including the restoration of the overall credit system and prevention of the contagion effect of crisis causing an economic recession. Regulatory procedure will help the distressed institutions to recover and shape up the bank behaviour through market discipline. (Berger et al., 2016; Mehran & Thakor, 2011). Further, stronger regulatory compliance may discipline the behaviour of bank management while strengthening the bank's monitory incentives (Dam & Koetter, 2012; Mehran & Thakor, 2011; Ratnovski et al., 2012).

On the other hand, it is argued that bailout policy measures cause more harm to the banking sector than good. According to Dam and Koetter (2012), bailout measures will increase the moral hazard behaviour in the banking industry due to the anticipation of bailout and the drastic reduction in market discipline. Gropp et al., (2011) further argue that bailout policy measures will distort the market competition in the banking industry, increasing the risk faced by the market participants, especially non-assisted once. However, Dam and Koetter (2012) have found evidence during their study, that moral hazard behaviour due to government safety net, can be mitigated through a thorough supervisory review mechanism in the banking industry. Although there is expectation that government bailouts will restore the value of distressed banks, there is evidence that it will not be the case always. Giannetti and Simonov (2013) argue that bailout packages are not always large enough to completely improve the

financial condition of the problem banks as the bailout will not accompany an efficient restructuring of the problem bank's statement of financial position. Fahri and Tirole (2012) identified that bailout regulatory policy will lead to collective moral hazard problems due to the cheap capital available to problem banks; they will invest in high-risk assets, increasing borrowings while reducing liquidity. Further, O'hara and Shaw (1990) found that due to the concept of "too-big-to-fail", big banks would tend to seek for higher risk than the smaller, as they are covered completely by government deposit insurance schemes. Gropp et al. (2011) emphasised on the importance of ownership structure to bank behaviour, as the government owned banks pursue high-risk investments more than privately owned banks. However, Dam and Koetter (2012) mentioned that political influence is also a strong element for bank bailouts and the subsequent bank behaviour will depend on the policies used to bailout the banks.

## 2.5 Impact of government bailouts on bank performance

Studies have been conducted measuring the performance of the banks during the financial crisis. Beltratti and Stulz (2012) found that during the recent financial crisis, bank performance was affected severely, due to the fragility of the banking system, as the banks were financed with short term capital market funds. During the time, better performing banks were equipped with less leverage and lower returns in the pre-crisis era. However, they argue that local bank regulations were not correlating with the bank performance during the crisis. Berger and Bouwman (2013) further found that small banks would be benefited from capital, as capital increases the probability of survival and market share, while enhancing the performance of larger and medium banks. Bertay et al. (2013) argue that bank performance may vary with the bank's choice of risk and return, the size of the bank, its funding mix and activity strategy. Grigorian and Manole (2006) further identified the effects of foreign ownership and powerful restructuring, which include enhancing bank efficiency and performance. They also assert that prudential tightening will vary with the prudential norms specific to the country of the bank and bank consolidation will improve performance.

Several techniques have been mentioned in prior literature relating to measuring the bank performance, including techniques such as data envelopment analysis and stochastic frontier analysis. However, Yeh (1996) found that financial ratios can be used to evaluate the quality of the management as well as financial performance of a bank although there is a disadvantage of ratios where single ratios need to be compared with benchmarks. Such ratios can be "capital adequacy, earnings, liquidity and deposit growth" (Yeh, 1996). Further Kumbirai and Webb (2010) confirm the usage of financial ratios in measuring the performance as well as the risk of a bank by using profitability, liquidity and credit quality performance ratios in their study, which measured the bank performance and risk during the recent financial turmoil.

## 2.6 Impact of government bailouts on bank risk taking

Effects of government bailout on bank behaviour will depend on the strategies used by the governments for the bailout and the policy mechanisms of the assisted banks (Dam & Koetter, 2012). Hakenes and Schnabel (2010) analysed the competitive effects on government bailout policies in the banking industry and found that bailout promotes low risk taking in the assisted banks and high risk taking within its competitor banks. They explain this phenomenon as, when the bailout measures increase the prospects of the assisted bank to expand, the competition within the industry will put pressure on the other bank margins, finally resulting in high risk taking within the industry. Based on ex-post observations, Demirgüç-Kunt and Huizinga, (2013); Gropp et al. (2011) mention that deposit insurance would promote high-risk behaviour within the banking industry, associated with moral hazards, although the expectation is that the capital access will reduce the risk-taking incentives of the protected banks.

However, some controversial results also have been found when studying the effects of bank bailout procedures in the bank risk taking. Berger et al. (2016) found that government capital injections to bailout a problem bank would improve the capital ratios of the bank without affecting the bank risk, regardless of the size of the bank. In contrast, Duchin and Sosyura (2014) argue that after receiving government assistance, bailed-out banks will create high risk loans, shifting the portfolio towards high risk securities. Since risk shifting is mostly within the same asset class, they will not be diagnosed by regulatory capital ratios, which then indicate improved capitalisation as appearing safe, while increasing default risk and volatility. Further, Black and Hazelwood (2013) found that size of the bank has an impact on risk taking behaviour. Larger banks will shift towards high risk taking, without increasing lending, due to moral hazards after government intervention, while the smaller banks try to reduce the risk of lending after government support. Black and Hazelwood (2013) further argue that risk taking has moved in different directions possibly due to the conflicting goals of the bailout programme.

Moreover, Hryckiewicz (2014) found that there is a strong correlation between the subsequent increase of risk in the banking sector and government interventions with a strong magnitude of the effect. It is argued that increasing risk is a result of inappropriate restructuring, inefficient management of banks as well as withdrawal of the governance mechanisms during the post intervention period. When there are extensive bailout programmes then there will be higher risks in the subsequent periods. Further to the moral hazard problem, the important role played by the government in the banking sector may encourage the self-interest of politicians, further leading to poor performance and higher risk in the bailed-out banks due to the unavailability of a proper restructuring mechanism (ibid:2014).

When analysing empirical evidence, there were very few research studies, that had been conducted in relation to the effects of government intervention in the banking sector of UK

and Europe. However, the author could not find evidence from the previous research studies conducted on the effects on performance and risk taking of bailed out banks due to government bailouts during the subsequent period of crisis.

Therefore, the purpose of this study is to fill the research gap by identifying the effects on performance and risk taking during the post bailout period in bailed out banks and provide valuable information to the markets, regulators and governments regarding the true effects of government interventions, by identifying the ways and means of overcoming or reducing the negative outcomes.

Accordingly, the research questions were developed as follows;

1. What is the effect of government bailouts reflected in the performance of bailout banks, during the post bailout period?

2. What is the effect of government bailouts in the risk-taking behaviour of the bailout banks, during the post bailout period?

## 3. Methodology

Based on prior literature, independent and dependent variables have been identified for this study. Independent variables are measured in terms of log of the amount of capital injections through credit guarantee schemes, special liquidity schemes, asset backed security schemes and asset protection schemes (Pazarbasioglu et al., 2011; NAO, 2010; Acharya & Yorulmazer, 2007; Hryckiewicz, 2014 and Ratnovski et al., 2012). Dependant variable - bank performance is measured in terms of bank performance ratios, which are, return on assets (ROA =net income/total assets), return of equity (ROE=net income/total equity) and net interest margin (NIM=net interest income/ average earning assets) (Beltratti & Stulz, 2012; Berger & Bouwman, 2013; Bertay et al., 2013; Kumbirai & Webb, 2010; Yeh, 1996). Accordingly, the hypothesis (H1) of the study has been derived as follows;

H1: All the other factors being constant, government bailout has a significant influence on bank performance in bailout banks

Independent variables are measured in terms of log of the amount of capital injections through credit guarantee schemes, special liquidity schemes, asset backed security schemes and asset protection schemes (Pazarbasioglu et al., 2011; NAO, 2010; Acharya & Yorulmazer, 2007; Hryckiewicz, 2014 and Ratnovski et al., 2012). Dependant variable bank risk taking, measured in terms of bank risk ratios, which are leverage ratio (total equity/total assets), loan ratio (net loans/total assets) and non-performing loans ratio (impaired loans/gross loans). (Dam & Koetter, 2012; Hakenes & Schnabel, 2010; Demirgüç-Kunt & Huizinga, 2013; Gropp et al., 2011; Berger et al., 2016; Duchin & Sosyura, 2014; Black & Hazelwood, 2013; Hryckiewicz, 2014). Accordingly, the hypothesis of the study (H2) has been derived as follows;

H2: All the other factors being constant, government bailout has a significant influence on bank risk taking in bailout banks

Capital injections data relating to the UK and Europe government bailedout banks can be found in the National Audit Office of the UK, in reports relating to financial system stability available online at www.nao.org.uk. Financial performance/risk ratios for the bailedout banks can be found in the Bankscope database. As the bailouts have been conducted during 2007-2009, the subsequent period from 2009 to 2015 will be considered for the study.

## 3.1 Model

A regression analysis will be conducted in order to evaluate the relationship between bailout and subsequent bank performance and risk taking. Hryckiewicz (2014), confirmed by Gropp et al. (2011), identified bank risk taking as a function of government intervention measures. Due to the effects of incentive monitoring, operating performance and risk premiums, bank performance and risk taking is expected to vary on the mechanisms used in a government bailout programme. Therefore, the model for bank performance (Per) and risk taking (Risk) for bank i in time period t, will be a function of bailout measures $X_{it}$.

Basic model for bank performance

$$Per_{it} = \alpha_0 + \alpha_1 * X_{i(t-n)} + \varepsilon_{it} \tag{1}$$

In the case of this research study, the above formula has to be expanded in order to reflect the effect of various bailout policy measures. $Per_{it}$ will be measured using separate panel regressions for $ROA_{it}$, $ROE_{it}$, $NIM_{it}$. Further, $Per_{it}$ will be a function of log of the total capital injections ($ln\_Capital_{i(t-n)}$) through credit guarantee scheme ($CG_{i(t-n)}$), special liquidity scheme ($SL_{i(t-n)}$), asset backed security scheme ($AB_{i(t-n)}$) and asset protection scheme ($AP_{i(t-n)}$), which are dummy variables adopting value one for usage of the scheme.

$$Per_{it} (ROA_{it} / ROE_{it} / NIM_{it}) = \alpha_0 + \alpha_1*ln\_Capital_{i(t-n)} + \alpha_2*CG_{i(t-n)} + \alpha_3*SL_{i(t-n)} + \alpha_4*AB_{i(t-n)} + \alpha_5* AP_{i(t-n)} + \varepsilon_{it} \tag{2}$$

Basic model for bank risk taking according to Hryckiewicz (2014) is;

$$Risk_{it} = \alpha_0 + \alpha_1 * X_{i(t-n)} + \varepsilon_{it} \tag{3}$$

In the expanded formula, $Risk_{it}$ will be measured using separate panel regressions for leverage ratio ($Leverage_{it}$), loan ratio ($Loan_{it}$) and non-performing loans ratio ($NPL_{it}$). Further, $Risk_{it}$ will be a function of log of the total capital injections ($ln\_Capital_{i(t-n)}$) through credit guarantee scheme ($CG_{i(t-n)}$), special liquidity scheme ($SL_{i(t-n)}$), asset backed security scheme ($AB_{i(t-n)}$) and

asset protection scheme $(AP_{i(t-n)})$ which are dummy variables, adopting value one for usage of the scheme.

$$Risk_{it} (Leverage_{it} / Loan_{it} / NPL_{it}) = \alpha_0 + \alpha_1*ln\_Capital_{i(t-n)} + \alpha_2*CG_{i(t-n)} + \alpha_3*SL_{i(t-n)} + \alpha_4*AB_{i(t-n)} + \alpha_5* AP_{i(t-n)} + \varepsilon_{it} \tag{4}$$

### 3.2 Measurement of data

Financial indicators that will be included in the analysis has to be standardised "in order to create indicators that are on the same scale and to avoid some of the variables to have greater influence on the index, then due to scale measurement" (Hryckiewicz, 2014; Popovska, 2014; Petrovska & Mihajlovska, 2013). Dependant variables will be standardized by subtracting the sample mean from the value of each individual observation in the sample for each bank and further, the difference is divided by the standard deviation of the sample for each bank. The standardisation of variables is a linear combination of the standardised value (Z-score) for each ratio. As an example, ROA for bank i at period t has been calculated as follows;

$$Zr_{it} = (R_{it} - \mu R_i) / \sigma R_i \tag{5}$$

Where; $Zr_{it}$ - Z-score of ROA for period t in bank i, $R_{it}$ - Value of ROA for period t in bank i; $\sigma R_i$ - Standard deviation of the value of ROA for bank i; $\mu R_i$ - Mean of the value of ROA for bank i.

This is a measure of relative standing, where the positive z-scores lie above the mean, while negative z-scores below the mean (Popovska, 2014). Further, it is highlighted that the "standardization of financial indicators is often applied in the construction of composite variables, especially in financial stability or financial stress indices, such as the indices of Hanschel and Monnin (2005) cited in Popovska (2014), the National Bank of Turkey, the National Bank of Albania and others".

### 3.3 The sample

The research study focuses on the bank bailouts, which have been conducted during the subsequent period (2007-2009) of the recent financial crisis, within the United Kingdom and European Union (EU). All the banks that were bailed out by the UK government and European Union have been selected for the study (altogether 16 banks). Majorly, the UK government has bailed out four banking groups during the recent financial turmoil. Further, 12 major banks from the Euro area were selected for the study (Country of Domicile attached in Appendix C). 264 observations have been made relating to the above banks. Nationalisation and subsequent privatisations have been conducted on these banks. These banks are existing in the post bail-out period under the same name or under the privatised name. Financial

performance and risk ratios during the post bailout period (2009-2015) were collected from the Bankscope database. Further, some of the quarterly ratios were calculated using quarterly financial statements of the selected banks. Data relating to the government interventions under credit guarantee schemes, special liquidity schemes, asset backed security schemes and asset protection schemes in the selected banks were gathered using the reports published by National Audit Office from 2009 to 2011.

## 3.4 Data analysis

Regression analysis was conducted to test the hypothesis of this study. Two hypotheses have been tested to measure the association of independent variables with the dependant variables. Hypotheses were tested using simple linear regressions (ordinary least square method) including the diagnosis tests to evaluate the regression model. In order to further confirm the results, a panel regression analysis was conducted for both hypotheses. Robustness of the results were tested with the usage of different dependant variables for performance as well as risk taking.

## 3.5 Relationship between government bailouts and bank performance

In order to test the hypothesis, $H_1$: All the other factors being constant, government bailouts have a significant influence on bank performance in bailout banks; the relationship between the log of the total capital flow and capital flow by several bailout packages were considered. The dependant variables used to measure performance were return on assets (ROA), return on equity (ROE) and net interest margin (NIM). Separate regressions (OLS and Panel) were conducted for dependant variables.

According to the test results, total capital flow reflects significant results relating to ROA (Table A2: regression 1) with a coefficient of -0.249098 with t statistic exceeding -1.96. It shows a negative relationship between the log of total bailout capital flow and ROA. Kumbirai and Webb (2010) have measured bank performance in terms of ROA and obtained similar results. Although Pazarbasioglu et al. (2011) have highlighted the significance of the structure of the bailout package, the individual schemes, which are corporate guarantee schemes, liquidity support schemes, asset backed security schemes and asset protection schemes do not show any significant relationship with the ROA. A similar kind of analysis have been conducted by Hryckiewicz (2014) with equity ratio where a negative effect was observed only in terms of corporate guarantee scheme while other schemes were insignificant. Adjusted $R^2$ is 39.87%, where 39.87% of the variation of ROA is explained by the included characteristics in terms of independent variables. Further, diagnostic tests were performed to evaluate the regression model, by testing for heteroscedasticity, presence of omitted variables and normality of the model.

The Breusch-Pagan / Cook-Weisberg test for heteroscedasticity provides a chi squared test statistic of 8.17 compared to the critical value of 12.59. Therefore, there is no evidence to reject the null hypothesis of the constant variance of the residual. The residual is homoscedastic and there is no presence of the heteroscedasticity in the model. Ramsey RESET test was performed to test the presence of omitted variables in the model and obtained Prob > F = 0.1443. Since p value is larger than 5% critical value, author fail to reject the null hypothesis, which is "the model does not have any omitted variables". Therefore, no omitted variables are present in the model. Jarque-Bera Lagrange multiplier test for normality was performed to test the normality of the residual. The chi squared value obtained is 13.00, exceeding the critical value of 5.99, rejecting the null hypothesis of residuals are normally distributed. This reflects the presence of outliers in the sample, which can be a common factor for financial performance ratios due to the high volatility.

A panel regression was performed to confirm the results between bailed out capital and ROA (Table A2: regression 2). Since it is believed that differences across the banks used for the study have some influence on the dependent variable (ROA), the random effects model has been used. Wald chi square value indicates 78.60 with probability value of 0.0000, which is less than 0.05. This reflects that the model has significant variables with coefficients different from zero. P value for ln_Capital variable is 0.0000, reflecting significant results showing a negative relationship with ROA with a coefficient of -0.2491. Results are in line with Kumbirai and Webb (2010) and Hryckiewicz (2014). However, the individual schemes, which are corporate guarantee schemes, liquidity support schemes, asset backed security schemes and asset protection schemes do not show any significant relationship with the ROA. However, the constant term is significant.

When regressing the government bailout package with the performance ratio ROE (Table A2: regression 3), log of total capital flow reflects significant results with a coefficient of -4.487936 with t statistic exceeding -1.96. It shows a negative relationship between the log of total bailout capital flow and ROE. The result is consistent with Kumbirai and Webb (2010) regarding the bank performance. However, the individual schemes, which are corporate guarantee schemes, liquidity support schemes, asset backed security schemes and asset protection schemes do not show any significant relationship with the ROE, reflecting contrasting results with Pazarbasioglu et al. (2011), while the constant is significant. Adjusted $R^2$ is 57.25%, where 57.25% of the variation of ROE is explained by the included characteristics in terms of independent variables. Further, diagnostic tests were performed to evaluate the regression model, by testing for heteroscedasticity, presence of omitted variables and normality of the model.

The Breusch-Pagan / Cook-Weisberg test for heteroscedasticity provides a chi squared test statistic of 7.81 compared to the critical value of 12.59. Therefore, there is no evidence to reject the null hypothesis of the constant variance of the residual. The residual is

homoscedastic and there is no presence of heteroscedasticity in the model. Further, the Ramsey RESET test was performed to test the presence of omitted variables in the model and Prob > F = 0.0800 was obtained. Since p value is larger than 5% critical value, author fail to reject the null hypothesis – "the model does not have any omitted variables". Therefore, no omitted variables are present in the model. The Jarque-Bera Lagrange multiplier test for normality was also performed to test the normality of the residual. The chi squared value obtained is 3.52 below the critical value of 5.99. Therefore, author fail to reject the null hypothesis of the model, which is "residuals are normally distributed". This reflects that there are no outlier observations in the sample.

According to the panel regression results relating to the random effects model between bailed out capital and ROA (Table A2: regression 4), Wald chi square value indicates 153.62 with probability value of 0.0000, which is less than 0.05. This reflects that the model has significant variables with coefficients different from zero. P value for ln_Capital variable is 0.0000, reflecting significant results, showing a negative relationship with ROE with a coefficient of -4.487936. Results are in line with Kumbirai and Webb (2010). However, the individual schemes, which are corporate guarantee schemes, liquidity support schemes, asset backed security schemes and asset protection schemes do not show any significant relationship with the ROE although the constant term is significant.

When regressing the government bailout package with the performance ratio NIM (Table A2: regression 5), log of total capital flow reflects that insignificant results with a coefficient of -0.04878 with t statistic of -1.26. Although Yeh (1996) and Kumbirai and Webb (2010) identify NIM as a significant performance measure, it did not provide significant results apart from showing a negative relationship between the log of total bailout capital flow and NIM. Further, the individual schemes, which are corporate guarantee schemes, liquidity support schemes, asset backed security schemes and asset protection schemes do not show any significant relationship with the NIM, reflecting contrasting results with Pazarbasioglu et al. (2011) while the constant is significant. Further, diagnostic tests were performed to evaluate the regression model, by testing for heteroscedasticity, presence of omitted variables and normality of the model.

The Breusch-Pagan / Cook-Weisberg test for heteroscedasticity provides a chi squared test statistic of 2.19 compared to the critical value of 12.59. Therefore, there is no evidence to reject the null hypothesis of constant variance of the residual. The residual is homoscedastic and there is no presence of the heteroscedasticity in the model. Furthermore, the Ramsey RESET test was performed to test the presence of omitted variables in the model and Prob > F = 0.9449 was obtained. Since p value is larger than 5% critical value, author fail to reject the null hypothesis which says, "model does not have any omitted variables". Therefore, no omitted variables present in the model. In addition, the Jarque-Bera Lagrange multiplier test for normality was performed to test the normality of the residual. The chi squared value

obtained is 0.35 below the critical value of 5.99, therefore, Author fail to reject the null hypothesis which says, "the residuals are normally distributed". This reflects that there are no outlier observations in the sample.

Panel regression results relating to the random effects model (Table A2: regression 6) confirms the above regression results, with Wald chi square value of 3.83 with probability value of 0.5746, which is above 0.05. This reflects that the model does not have any significant variables with coefficients different from zero. P value for ln_Capital variable is 0.208, reflecting insignificant results, showing a negative relationship with NIM with a coefficient of -0.4878. Further, the individual schemes, which are corporate guarantee schemes, liquidity support schemes, asset backed security schemes and asset protection schemes do not show any significant relationship with the NIM although the constant term is significant.

### 3.6 Robustness of the results

Out of the three performance ratios, ROA and ROE provided significant negative regression results with the log of total government bailout capital flow, proving the robustness of the results of the regression analysis conducted. However, NIM provided insignificant results for the regressions conducted. But the sign of the coefficient was negative confirming the negative, association between the government bailouts and bank performance in the post bailout period.

In order to understand the robustness of the results further, a model for crisis was developed. A dummy variable 'crisis' was added to the regressions, where it represents one for the crisis year (2008-2009) and all the other years represents zero, controlling for the crisis. According to results of the crisis model (Table A2: regression 7), crisis variable is significant with a t value of 3.32, reflecting that financial crisis has a significant effect on bank performance, while ln_Capital variable is also significant, showing a negative relationship between ROA and log of capital flow, which reflects robust results with the prior regressions. Table A2: regression 8 represents the crisis model regression summary with performance ratio ROE, crisis variable is significant with a t value of 2.44, reflecting the significant effect on bank performance due to financial crisis, while ln_Capital variable is also significant showing a negative relationship between ROE and log of capital flow, which reflects robust results. Table A2: regression 9 represents crisis model regression summary with performance ratio NIM, crisis variable is significant with a t value of 2.31, while ln_Capital variable is insignificant but shows a negative relationship between NIM and log of capital flow, which reflects robust results.

### 3.7 Relationship between government bailouts and bank risk taking

In order to test the hypothesis, $H_2$: all the other factors being constant, government bailout has a significant influence on bank risk taking in bailout banks, the relationship between the log of the total capital flow and capital flow under several bailout packages were considered.

The dependant variables used to measure bank risk taking were leverage ratio (leverage), loan ratio (loan) and non-performing loans ratio (NPL). Separate regressions (OLS and Panel) were conducted for dependant variables.

When regressing the government bailout package with the risk ratio leverage (Table A3: regression 10), log of total capital flow reflects significant results with a coefficient of 0.2224266 with t statistic of 2.98 exceeding 1.96. It shows a positive relationship between the log of total bailout capital flow and leverage. Beltratti and Stulz (2012) also have found similar results in their study, building a positive relationship with leverage. Further, Bertay et al. (2013) highlighted the importance of risk and return in bailouts. This result is consistent with the findings of Hryckiewicz (2014), as the bailout capital has increased risk in the intervened banks. However, this result contrasts with the results of Hakenes and Schnabel (2010) and Berger et al. (2016). The individual schemes, which are corporate guarantee schemes, liquidity support schemes and asset backed security schemes do not show any significant relationship with the leverage, reflecting contrasting results with Pazarbasioglu et al. (2011) but asset protection scheme shows significant results. However, Dam and Koetter (2012) has found that the structure of the bailout package is significant in their study. Adjusted $R^2$ is comparatively low, which is 5.38%, where only 5.38% of the variation of leverage is explained by the included characteristics in terms of independent variables. Further, diagnostic tests were performed to evaluate the regression model, by testing for heteroscedasticity, presence of omitted variables and normality of the model.

The Breusch-Pagan / Cook-Weisberg test for heteroscedasticity provides a chi squared test statistic of 0.59 compared to the critical value of 12.59. Therefore, there is no evidence to reject the null hypothesis of constant variance of the residual. The residual is homoscedastic and there is no presence of the heteroscedasticity in the model. The Ramsey RESET test was performed to test the presence of omitted variables in the model and Prob > F = 0.7722 was obtained. Since p value is larger than 5% critical value, author fail to reject the null hypothesis which says, "model does not have any omitted variables". Therefore, no omitted variables are present in the model. The Jarque-Bera Lagrange multiplier test for normality was performed to test the normality of the residual. The chi squared value obtained is 6.99, exceeding the critical value of 5.99, therefore, reject the null hypothesis which says, "residuals are normally distributed". This reflects that there are outlier observations in the sample, may be due to the high volatility of leverage ratio during the post bailout period.

Panel regression results relating to the random effects model between leverage and log of capital flow (Table A3: regression 11) confirm the above regression results, with a Wald chi square value of 11.31 with probability value of 0.0455, which is below 0.05. This reflects that the model has significant variables with coefficients different from zero. P value for ln_Capital variable is 0.003, reflecting significant results, showing a positive relationship with leverage with a coefficient of 0.2224266. However, the individual schemes, which are corporate

guarantee schemes, liquidity support schemes and asset backed security schemes do not show any significant relationship with the leverage, while asset protection schemes show a significant relationship.

When regressing the government bailout package with the risk ratio loan (Table A3: regression 12), log of total capital flow reflects significant results with a coefficient of -11.93315 with t statistic of -16.83 exceeding -1.96. It shows a negative relationship between the log of total bailout capital flow and loan. This result contrasts with the result of Duchin and Sosyura (2014) as they found that bailed out banks will increase their loan portfolios creating high risk loans shifting the portfolio to high risk. But according to obtained results, this study shows a reduction in loan ratio. However, the individual schemes, which are corporate guarantee schemes, liquidity support schemes and asset backed security schemes do not show any significant relationship with the loan, reflecting contrasting results with Pazarbasioglu et al. (2011) and Dam and Koetter (2012), while asset protection schemes show a significant relationship. Adjusted $R^2$ is high, which is 72.37%, where 72.37% of the variation of loan is explained by the included characteristics in terms of independent variables. Further, diagnostic tests were performed to evaluate the regression model, by testing for heteroscedasticity, presence of omitted variables and normality of the model.

The Breusch-Pagan / Cook-Weisberg test for heteroscedasticity provides a chi squared test statistic of 0.36 compared to the critical value of 12.59. Therefore, there is no evidence to reject the null hypothesis of constant variance of the residual. The residual is homoscedastic and there is no presence of the heteroscedasticity in the model. The Ramsey RESET test was performed to test the presence of omitted variables in the model and Prob > F = 0.0920 was obtained. Since p value is larger than the 5% critical value, author fail to reject the null hypothesis, which says "model does not have any omitted variables". Therefore, no omitted variables are present in the model. The Jarque-Bera Lagrange multiplier test for normality was performed to test the normality of the residual. The chi squared value obtained is 4.98, below the critical value of 5.99, therefore, author does not reject the null hypothesis which says, "residuals are normally distributed". This reflects that there are no outlier observations in the sample.

Panel regression results relating to the random effects model between loan and log of total capital (Table A3: regression 13) confirms the above regression results, with Wald chi square value of 295.73 with probability value of 0.0000, which is below 0.05. This reflects that the model has significant variables with coefficients different from zero. P value for ln_Capital variable is 0.0000, reflecting significant results, showing a negative relationship with loans, with a coefficient of -11.93315. This result contrasts with the result of Duchin and Sosyura (2014). However, the individual schemes, which are corporate guarantee schemes, liquidity support schemes and asset backed security schemes do not show any significant relationship with the

loan, while asset protection schemes show a significant relationship. The constant is significant.

When regressing the government bailout package with the risk ratio NPL (Table A3: regression 14), log of total capital flow reflects significant results with a coefficient of 2.647934 with t statistic of 15.66 exceeding 1.96. It shows a positive relationship between the log of total bailout capital flow and the NPL. This result is consistent with the findings of Hryckiewicz (2014), as the bailout capital has increased risk in the intervened banks. However, this result contrasts with the results of Hakenes and Schnabel (2010) and Berger et al. (2016) as they mention a reduction in risk after injection of bailed out capital. Further, the individual schemes, which are corporate guarantee schemes, liquidity support schemes, asset backed security schemes and asset protection schemes do not show any significant relationship with the NPL, showing contrasting results with Dam and Koetter (2012) and Pazarbasioglu et al. (2011). Adjusted $R^2$ is high, which is 69.09%, where 69.09% of the variation of the NPL is explained by the included characteristics in terms of independent variables. Further, diagnostic tests were performed to evaluate the regression model, by testing for heteroscedasticity, presence of omitted variables and normality of the model.

The Breusch-Pagan / Cook-Weisberg test for heteroscedasticity provides a chi squared test statistic of 6.09 compared to the critical value of 12.59. Therefore, there is no evidence to reject the null hypothesis of constant variance of the residual. The residual is homoscedastic and there is no presence of the heteroscedasticity in the model. The Ramsey RESET test was performed to test the presence of omitted variables in the model and Prob > F = 0.9160 was obtained. Since p value is larger than 5% critical value, author fail to reject the null hypothesis which says, "model does not have any omitted variables". Therefore, no omitted variables are present in the model. The Jarque-Bera Lagrange multiplier test for normality was performed to test the normality of the residual. The chi squared value obtained is 2.61, below the critical value of 5.99. Therefore, do not reject the null hypothesis which says, "residuals are normally distributed". This reflects that there are no outlier observations in the sample.

Panel regression results relating to the random effects model between NPL and total capital flow (Table A3: regression 15) confirm the above regression results, with a Wald chi square value of 253.10, with a probability value of 0.0000, which is below 0.05. This reflects that the model has significant variables with coefficients different from zero. P value for ln_Capital variable is 0.0000, reflecting significant results, showing a positive relationship with the NPL with a coefficient of 2.647934. However, the individual schemes, which are corporate guarantee schemes, liquidity support schemes, asset backed security schemes and asset protection schemes do not show any significant relationship with the NPL, while the constant is significant.

### 3.8 Robustness of the results

Out of the three risk ratios, leverage and the NPL provided significant positive regression results with the log of total government bailout capital flow, proving the robustness of the results of the regression analysis conducted. However, loan provided significant negative results for the regressions conducted. But the negative sign of the coefficient for loan indicates that the behaviour of bailed out banks reducing its loan portfolios still increases the risk of the bank, confirming the positive association between the government bailouts and bank risk taking in the post bailout period.

In order to understand the robustness of the results further, a model for crisis was developed. A dummy variable 'crisis' was added to the regressions, where it represents 'one' for the crisis year (2008-2009) and all the other years represent 'zero', controlling for the crisis. According to the results of the crisis model (Table A3: regression 16) the crisis variable is significant with a t value of -5.72, reflecting that financial crisis has significant influence over risk taking, while ln_Capital variable is also significant, showing a positive relationship between leverage and log of capital flow, which reflects robust results.

Table A3: regression 17 represents the crisis model regression summary with risk ratio loan. Crisis variable is significant with a t value of -3.85, while ln_Capital variable is significant showing a negative relationship between loan and log of capital flow, which reflects robust results.

Table A3: regression 18 represents the crisis model regression summary with risk ratio NPL. Crisis variable is significant with a t value of -3.07, while ln_Capital variable is significant showing a positive relationship between NPL and log of capital flow, which reflects robust results.

### 3.9 Consistency of the results to South Asia

In order to further confirm the robustness of the study, a replication was performed using the yearly data relating to aftermath performance and risk of four South Asian banks (Three in India and one in Pakistan) which were bailed out during 2009 – 2015. The crisis model was used to reflect the crisis years for the respective banks. The three performance ratios ROA, ROE and NIM provided significant negative regression results with the log of total government bailout capital flow confirming the negative association between the government bailouts and bank performance in the post bailout period. Out of the three risk ratios, leverage and NPL provided significant positive regression results with the log of total government bailout capital flow, proving the positive association between the government bailouts and bank risk taking in the post bailout period, while confirming consistency of the results of the regression analysis conducted in relation to the UK and Europe.

## 4. Findings

As per the discussion in the earlier chapter, the estimation results of both hypotheses are consistent with expectations and the prior literature. Out of the three performance ratios ROA and ROE provided significant negative regression results with the log of total government bailout capital flow. However, NIM provided insignificant results for the regressions conducted. But the sign of the coefficient was negative, confirming the negative association between the government bailouts and bank performance in the post bailout period. This result is consistent with the view that government interventions tend to decrease the performance due to inefficient banking structure. (Sironi, 2003; Flannery, 1998).

Further, out of the three risk ratios, leverage and NPL provided significant positive regression results with the log of total government bailout capital flow. However, loan provided significant negative results for the regressions conducted, while leverage and NPL confirm the positive association between the government bailouts and bank risk taking in the post bailout period. This result is consistent with the view that government interventions tend to increase risks in the bailed-out banks due to the incentive to reduce the market discipline (Hryckiewicz, 2014; Gropp & Vesela, 2004).

Several reasons can be identified with regard to the decrease in performance and increase in risk in the bailed-out banks during the post bailed out period. One of the main reasons as identified in literature is, after conducting severe processes of government interventions, the bailed-out banks are more likely to undermine the market discipline, which then encourage banks to increase their risk levels. The cause for this behaviour is that the depositors perceive the bailed-out banks as government protected, thus they have no incentives to conduct a rigorous and careful process of monitoring (Baumann & Nier, 2006).

According to the results of the study, the government bailout capital flow will exert negative effects with the bailed-out bank behaviour in terms of performance and positive effects in terms of risk taking due to the increased level of risk taking. As highlighted above, due to the subsequent effects of reducing market discipline, moral hazard considerations may take place within the bailed-out banks (Dam & Koetter, 2012). Fahri and Tirole (2012) further confirmed this matter, as bailout regulatory policy will lead to collective moral hazard problems due to the cheap capital available to problem banks. This problem arises if one bank starts gambling; soon the other banks also follow, increasing the risk of the whole banking system. It is indicated that broader government protections and nationalisations will increase the banking sector risk individually as well as collectively. According to Hryckiewicz (2014), reduction in performance and increasing risk during post bailed out period can be due to three major reasons;

1. Reduced market discipline
2. Inefficient bank management
3. Lack of a proper restructuring process to help the bank to recover from the distressed status.

However, according to Dell'Ariccia and Ratnovski (2012), increasing regulatory actions will be a remedy for this problem, as it is likely to attract market scrutiny, which can be a way of disciplining the bailed-out bank's management. Through appropriate policy measures, governments may initiate greater public scrutiny of the bailed-out banks during periods of financial turmoil, leading to bail outs and the post bailed out periods (Hryckiewicz, 2014).

To test the robustness of the result, several regressions were performed. When controlling for the crisis years also, the analysis provided robust results. It can be argued that the type of financial shock and the magnitude of the effects of the shock also will have significant influence on the performance and risk taking in the post bailed out period (Hryckiewicz, 2014).

According to the results, structure of the bailout package in terms of the individual bailout policy measures, which are corporate guarantee schemes, liquidity support schemes, asset backed security schemes and asset protection schemes do not show any significant influence on the bailed-out bank performance and risk. This indicates that the structure of the bailout package itself is not important in the case of bailed out banks, instead the total bailout capital flow is the only significant factor for the bailed-out banks, as the estimates on structure does not indicate a true effect on the neither performance nor risk. This cause was confirmed by Giannetti and Simonov (2013) as they assert that the amount of financial assistance received through the bailed-out policy measures influence the bank risk taking behaviour. Estimation results of the study showed no significance, may be due to the fact that individual dummies do not explicitly control the size of the total bailout capital flow injected to each bank under each scheme. Further, Dam and Koetter (2012) have argued that bank performance and risk taking in the post bailed out period is dependent on the policy measures injected to the bank by various schemes, where such information will be lacking in the case of this research study. Therefore, various schemes cannot be directly controlled, without having such bank specific information.

## 4.1 Policy implications

The findings reveal important policy implications. Firstly, the results show a significant risk increase in the banking sector due to bail outs, which is an important factor in the case of regulators' perspective. Thus, the results contribute to the current debacle, whether the governments should bail out the banks or not. Further, it creates pressure on governments to assess the true effects of government intervention, relating to the smooth functioning of the banking systems of a country and to shape up bank regulation by carefully selecting policies to be implemented. The theoretical evidence suggests that if government bailouts are crucial, then market controls and regulatory monitoring have to be aggravated (Hryckiewicz, 2014).

The next important factor to consider is that importance of government bailouts in economic perspectives. If a large bank fails in an economy, the damages will be detrimental due to the contagion effects on the financial system. If one bank fails the general public will lose the

confidence about the whole financial system where all the borrowers and lenders will have to face the severe effects as the systemic effect will spread to the whole financial system. When the financial system is vulnerable to a crisis, it will have direct effects on domestic production due to the lack of credit, and the country will be running towards an economic recession due to the lowering output and increasing unemployment. Due to the instability that will be created on interest rates and exchange rates, the external sector will be imbalanced, affecting the international trade while severely affecting the balance of payment. In such a situation, the global outlook of a country will be negative and the foreign investments will be lowered, damaging the economy further. Therefore, the importance of bailouts to governments can be highlighted in order to overcome the negative economic impact of a financial turmoil.

Another aspect that has to be considered in relation to bank bailouts, is the moral hazard behaviour. It is argued that moral hazard behaviour of banks will be simulated when they receive government support in terms of bailout packages. Failure of a single bank will hamper the confidence in the whole banking system, and a too lenient regulator will create incentives for banks to take on excessive risk with the government interventions (Cordella & Yeyati, 2003).

Bailing out of banks has a long history where different countries have attempted several structural reforms in order to overcome a crisis. Particularly in the US, the setting up of the Federal Reserve System in 1914 and the setting up of the Federal Deposit Insurance Corporation in 1934 are a part of structural reforms to combat bank crises. During the subsequent period of the recent turmoil, although the recovery of the global economy has been modest, the volatility in the international financial markets remained heightened. Slowing down of international trade, rising debt levels in the international markets especially in the EU area also have significantly influenced the performance of the banking sector.

Considering the macroeconomic impact of a bank crisis, several regulatory reforms have been developed to surface a crisis. With the implementation of Basel III, introducing additional capital cushion to absorb losses, reduce leverage and high liquidity, advanced stress testing and bail-in packages for relatively large problem banks can be identified as some of measures.

## 5. Conclusions

The study was conducted using the data of all the bailed-out banks within the UK and Europe bailed out by the governments during the recent financial turmoil of 2007-2009. The database facilitated the investigation of the behaviour in terms of performance and risk taking of the bailed-out banks during the post bailed out period. Two hypotheses were developed through the literature survey and tested using the regression analysis. Few conclusions can be made considering the findings of the study.

Although it is argued that government interventions in terms of bailouts are important and it helps governments to limit the negative consequences in terms of systemic risks to the

financial systems during a financial turmoil, the estimation results reflect that bailouts are associated with subsequent reduction in performance and increase in risk during the post bailed out period. Further, literature suggests that, this can be an effect of the reduced market discipline, inefficient bank management and lack of a proper restructuring process within the bailed-out banks (Hryckiewicz, 2014). Further, a region-wise structural resolution framework can be developed and implemented, which can be used at a time of a bank crisis.

Moreover, the estimation results further revealed that the structure of the bailed-out package in terms of corporate guarantee schemes, liquidity support schemes, asset backed security schemes and asset protection schemes are not significant to the bailed-out banks, but the total capital flow is highly significant to the bailed-out banks. The evidence proved to be robust to the modifications such as controlling for the crisis years, use of different performance and risk measures to measure performance and risk. Further, results were consistent with the bailed-out banks in the South Asian region as well according to the test results.

## 5.1 Limitations of the study

The main focus of the study was limited to the banks that were bailed out by the governments of the UK and Europe. The comparative effects cannot be measured compared to the non-bailed out banks, which goes beyond the "inherited risk portion" of the bailed-out banks. Therefore, the effects from the non-bailed out banks could not be controlled, which may finally have an effect on the endogeneity of the study. The difference-in-differences estimation method could have been used to compare the behaviour of non-assisted banks. The assisted banks could be separated for two-time periods, as during the time of intervention and during the post bailed out period, if a controlling group of non-assisted banks were to be included in the study. Further, due to the non-availability of scheme-specialised information of the government bailout packages, those data cannot be used in the study.

## 5.2 Areas for further research

This study was conducted considering the bailed-out banks within the UK and Europe. However, the results were consistent for the banks in the South Asian region as well. The study can further be extended, controlling for different types of financial crises in different countries, controlling for the magnitude of the financial crises, as a whole will provide more precise findings regarding the bank behaviour. Particularly, during the recent financial crisis, although the US and Europe were severely affected, Asia and Africa were not affected in that magnitude of the crisis. Therefore, a novel research study can be conducted considering the reasons for the above fact, while discussing the behaviour of Asian banks precisely during a financial crisis. Further, the study can be extended considering the macroeconomic conditions of the domicile countries, including a control group of non-bailed out banks also to the sample.

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## Appendices

### Table A1: Descriptive statistics

| Variable | Data Range | Minim- um | Maxim -um | Mean | Std. Error | Median | Mode | Std. Deviation | Variance | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ROA | 2.24 | -0.77 | 1.47 | 0.109 | 0.0398 | 0.04 | -0.06 | 0.421 | 0.1772 | 0.7872 | 4.2644 |
| ROE | 31.07 | -13.21 | 17.86 | 1.525 | 0.6149 | 0.115 | -0.06 | 6.5078 | 42.3514 | 0.5288 | 3.7805 |
| NIM | 1.92 | 0.14 | 2.06 | 1.138 | 0.0416 | 1.1115 | 1.12 | 0.4399 | 0.1935 | -0.0217 | 2.7158 |
| Leverage | 5.19 | 2.55 | 7.74 | 4.849 | 0.0829 | 5.0385 | 5.78 | 0.8771 | 0.7693 | -0.2381 | 3.5808 |
| Loan | 59.72 | 26.15 | 85.87 | 57.56 | 1.4551 | 59.445 | 36.95 | 15.3992 | 237.1339 | 0.443 | 2.2984 |
| NPL | 9.97 | 0.41 | 10.38 | 4.068 | 0.3283 | 2.773 | 2.88 | 3.474 | 12.0683 | 0.5092 | 1.6209 |
| ln_capital | 2.75 | 23.72 | 26.47 | 25.01 | 0.1059 | 24.929 | 23.71 | 1.121 | 1.2567 | 0.1164 | 1.2962 |

Observations: 264

### Table A2: Regression results at 95% confidence interval for relationship between government bailouts and bank performance

| Dependent / Independent | ROA OLS (1) | ROA Panel (2) | ROE OLS (3) | ROE Panel (4) | NIM OLS (5) | NIM Panel (6) | Crisis ROA (7) | Crisis ROE (8) | Crisis NIM (9) |
|---|---|---|---|---|---|---|---|---|---|
| ln_Capital | 0.000*** (0.029) | 0.000*** (0.028) | 0.000*** (0.373) | 0.000*** (0.373) | 0.211 (0.038) | 0.208 (0.038) | 0.000*** (0.027) | 0.000*** (0.364) | 0.229 (0.037) |
| CG | 0.933 (0.068) | 0.933 (0.068) | 0.496 (0.889) | 0.495 (0.889) | 0.804 (0.092) | 0.803 (0.092) | 0.709 (0.065) | 0.725 (0.878) | 0.568 (0.091) |
| SL | 0.782 (0.072) | 0.782 (0.071) | 0.976 (0.937) | 0.976 (0.937) | 0.616 (0.097) | 0.615 (0.097) | 0.960 (0.068) | 0.837 (0.918) | 0.730 (0.095) |
| AB | 0.298 (0.072) | 0.296 (0.072) | 0.371 (0.946) | 0.369 (0.946) | 0.643 (0.098) | 0.642 (0.098) | 0.570 (0.070) | 0.595 (0.935) | 0.909 (0.097) |
| AP | 0.425 (0.074) | 0.423 (0.074) | 0.759 (0.970) | 0.758 (0.970) | 0.198 (0.100) | 0.195 (0.100) | 0.512 (0.071) | 0.657 (0.949) | 0.235 (0.098) |
| _Cons | 0.000 (0.696) | 0.000 (0.696) | 0.000 (9.073) | 0.000 (9.072) | 0.017 (0.943) | 0.000 (0.943) | 0.001 (0.086) | 0.016 (8.873) | 0.023 (0.925) |
| Crisis | - | - | - | - | - | - | 0.000*** (0.037) | 0.000*** (1.152) | 0.001*** (0.120) |
| R-squared/ model significance | 0.3987 | 0.0000 | 0.5725 | 0.0000 | 0.034 | 0.5746 | 0.4506 | 0.5915 | 0.0288 |

Note: Standard errors are in the parenthesis, ***p<0.01, **p<0.05, *p<0.1, ln_Capital stands for the log of total capital flow, CG - corporate guarantee schemes, SL - liquidity support schemes, AB - asset backed security schemes and AP - asset protection schemes

**Table A3: Regression results at 95% confidence interval for relationship between government bailouts and bank risk taking**

| Dependent ⟍ Independent | Leverage OLS (10) | Leverage Panel (11) | Loan OLS (12) | Loan Panel (13) | NPL OLS (14) | NPL Panel (15) | Crisis Leverage (16) | Crisis Loan (17) | Crisis NPL (18) |
|---|---|---|---|---|---|---|---|---|---|
| ln_Capital | 0.004** | 0.003** | 0.000*** | 0.000*** | 0.000*** | 0.000*** | 0.002** | 0.000*** | 0.000*** |
| | (0.074) | (0.075) | (0.708) | (0.708) | (0.169) | (0.169) | (0.065) | (0.667) | (0.162) |
| CG | 0.779 | 0.779 | 0.324 | 0.322 | 0.109 | 0.106 | 0.633 | 0.612 | 0.220 |
| | (0.178) | (0.178) | (1.692) | (1.692) | (0.403) | (0.404) | (0.158) | (1.608) | (0.392) |
| SL | 0.703 | 0.703 | 0.635 | 0.634 | 0.154 | 0.151 | 0.399 | 0.820 | 0.090 |
| | (0.188) | (0.188) | (1.783) | (1.783) | (0.425) | (0.425) | (0.165) | (1.681) | (0.411) |
| AB | 0.713 | 0.712 | 0.663 | 0.662 | 0.641 | 0.640 | 0.642 | 0.296 | 0.994 |
| | (0.190) | (0.189) | (1.799) | (1.799) | (0.429) | (0.429) | (0.168) | (1.713) | (0.418) |
| AP | 0.044 | 0.042 | 0.035 | 0.033 | 0.054 | 0.051 | 0.047 | 0.015 | 0.066 |
| | (0.195) | (0.194) | (1.846) | (1.845) | (0.440) | (0.440) | (0.170) | (1.738) | (0.424) |
| _Cons | 0.876 | 0.870 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.003 |
| | (1.819) | (1.819) | (17.25) | (17.26) | (4.118) | (4.118) | (1.597) | (16.24) | (3.965) |
| Crisis | - | - | - | - | - | - | 0.000*** | 0.000*** | 0.000*** |
| | | | | | | | (0.207) | (2.108) | (0.515) |
| R_Squared/ Model Significance | 0.538 | 0.045 | 0.724 | 0.000 | 0.690 | 0.000 | 0.272 | 0.755 | 0.714 |

Note: Standard errors are in the parenthesis, ***p<0.01, **p<0.05, *p<0.1, ln_Capital stands for the log of total capital flow, CG - corporate guarantee schemes, SL - liquidity support schemes, AB - asset backed security schemes and AP - asset protection schemes

**Figure A1: Average return on assets (ROA), Average return on equity (ROE), Average net interest margin (NIM), Average Leverage, Average loan ratio and Average non-performing loan ratio over 2010 -2015 period for the bailed out banks in UK and Europe.**
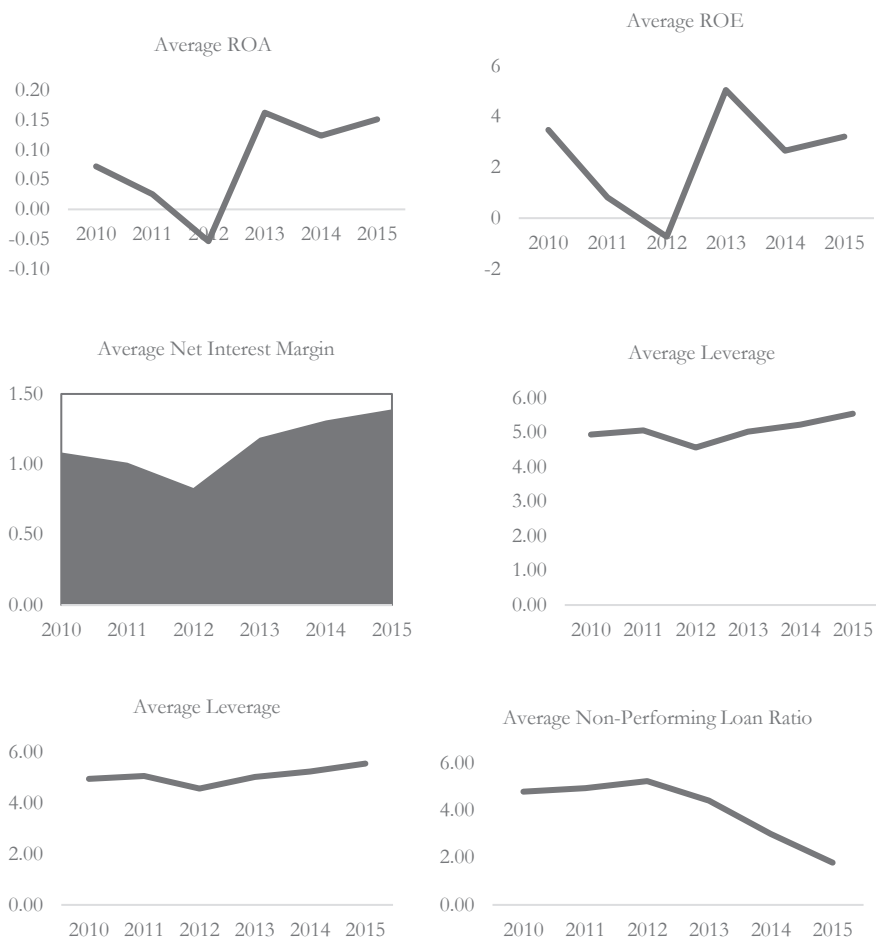


Source: Bankscope data

**Figure A2: Scheme wise total capital flow from the UK and EU governments to the bailed-out banks**

Capital Flow in £ billions
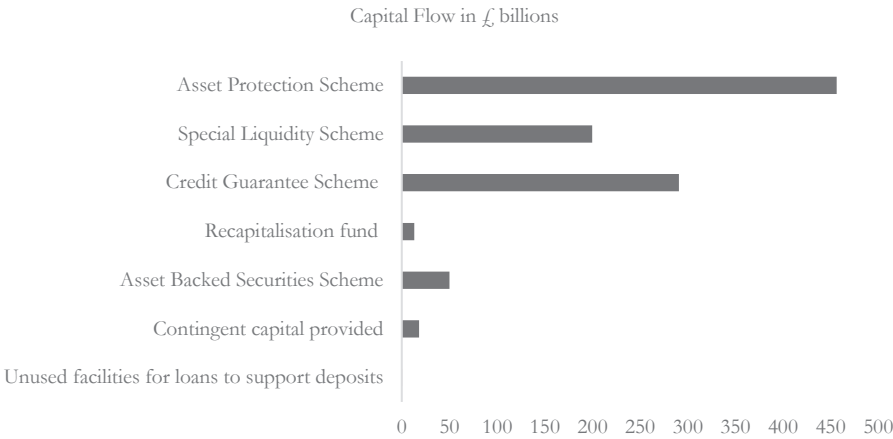


Source: National Audit Office of UK

**Table A4: Domicile Countries of selected banks**

| United Kingdom | |
|---|---|
| European Union | Germany |
| | Austria |
| | France |
| | Greece |
| | Ireland |
| | Portugal |
| | Finland |
| | Poland |
| | Spain |
| South Asia | India |
| | Pakistan |

# Is Public Debt Harmful Towards Economic Growth?
# New Evidence from Sri Lanka

*Thilak Ranjeewa Priyadarshana[1]*

## Abstract

*This study examines the impact of public debt on economic growth and investment in Sri Lanka during the period from 1977 to 2017. The two model specifications, growth model and investment model, are estimated using the Johansen Cointegration technique and the Vector Error Correction Model (VECM) specified under the Vector Auto Regressive (VAR) framework using annual data for the period of 1977-2017. The results of the two models reveal that public debt, which consists of foreign debt and domestic debt, has a significant and positive impact on economic growth and investment in the long run. In the short run, a significant association between public domestic debt and economic growth as well as total public debt and investment is observed, suggesting mixed results. Debt service payments in the long run show a significant negative effect on both economic growth and investment, reflecting a crowding out investment. The finding suggests that using government debt for priority investment expenditures with a prudent debt management strategy to curtail the impact of crowding out investment will have a favourable impact on economic growth of the country, particularly in the long run.*

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[1] The author is currently serving as a Senior Economist of the Economic Research Department. Corresponding email: priyadarshana@cbsl.lk. The author wishes to thank the anonymous reviewers for their comments and advice. The views presented in this paper are those of the author and do not necessarily indicate the views of the Central Bank of Sri Lanka.

## 1. Introduction

The impact of public debt[2] on economic growth is a controversial and debated issue in many countries, particularly in developing economies (Deshappriya 2012). In literature, there is no consensus as to whether public debt affects economic growth positively or negatively (Mhlaba 2017). However, academic opinion on the impact of public debt on economic growth can be divided into three stands (Munir 2015; Oleksandr 2003). The first stand is that there is a positive association between public debt and economic growth. This implies that public debt stimulates economic growth through investments in infrastructure, education, health, social welfare and other development activities (eg., Kobayashi 2015; Nantwi 2016; Wibowo 2017). The second stand suggests a negative correlation between public debt and economic growth (eg., Atique 2012; Mhlaba 2017; Akram 2016). On the negative front, higher accumulation of public debt adversely affect on economic growth as described by the "debt overhang" effect, "crowding out" effect and "uncertainty" effect. Debt overhang effect asserts that if the country's accumulated debt stock is larger than its repayment ability in the future, the expected debt service cost will increase hindering further investments. The crowding out effect implies that higher accumulated foreign debt and resulted debt servicing costs lead to crowd out expenditure on public investments by reducing country's investments directly and complementary expenditure indirectly. The uncertainty created by debt in the shape of possibilities of default, adversely affect investor sentiments and thereby future inflows and additional lending. The third stand of the impact of public debt suggests a nonlinear trend among public debt and economic growth (eg., Saira 2016; Kobayashi 2015; Weerasinghe 2010). Under the nonlinear relationship, public debt positively affects economic growth up to a certain point, referred to as the "threshold level" and thereafter it inverts into a negative impact (Mencinger 2014).

A number of studies have been carried out to examine the effect of public debt on economic growth and they provide inconsistent and mixed results. Most studies generally focus on public external debt, while others have analysed both external and domestic debt. Various methods including Ordinary Least Square (OLS), Engle-Granger Cointegration test, Johanson Maximum Likelihood Cointegration test with Vector Auto Correction Model (VECM), Autoregressive Distributed Lag (ARDL) model, Standard Panel data model and Generalised Method of Moment (GMM) have been used to estimate the regressions. In the context of Sri Lanka, there are limited studies: e.g., Fonseka and Ranasinghe (2008), Kumara and Cooray (2013), Akram (2013), which have addressed the issue of increasing public debt and its impact on the country's economic growth. Thus, the author aims to fill this gap in the literature by carrying out a comprehensive analysis extending the data set for the last 41 years. Further, the

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[2] In this study, Central Government Debt of Sri Lanka, which comprises both domestic and foreign debt, is considered as the public debt.

study hopes to investigate both long run and short run impacts of increasing public debt on economic growth and investment in Sri Lanka.

The rest of the paper is divided into five sections: section two provides an overview on the nexus of public debt and economic growth in Sri Lanka; section three describes the empirical evidences covering the theoretical background. The research methodology applied to estimate the models is described in section four, while the interpretation of the results is reported in section five. Finally, section six provides the conclusion and recommendations of the study.

## 2. Nexus between public debt and economic growth in Sri Lanka: an overview

Sri Lanka's outstanding government debt has gradually mounted to a staggering level over the past few decades and in some periods, it has been recorded to be above GDP. The central government debt in Sri Lanka, which reported 17 as a percentage of GDP[3] in 1950 increased to 34 per cent, 64 per cent, 77 per cent, 97 per cent and 97 per cent, respectively in the 1960s, 1970s, 1980s, 1990s and 2000s. The debt to GDP ratio peaked at 109 per cent in 1989, and was above 100 per cent during the periods of 1988-1989 and 2001-2004 before stagnating around 78 per cent during 2005-2017 (Figure 1).

In terms of the composition of total debt, Sri Lanka tended to highly depend on foreign debt with the liberalization of the economy in 1977. As a result, the share of foreign debt in the total debt portfolio gradually increased to 62 per cent in 1989 from 28 per cent in 1976. The share of foreign debt stood at 36 per cent in 2017 (Figure 1).

**Figure 1: Outstanding government debt as a percentage of GDP**
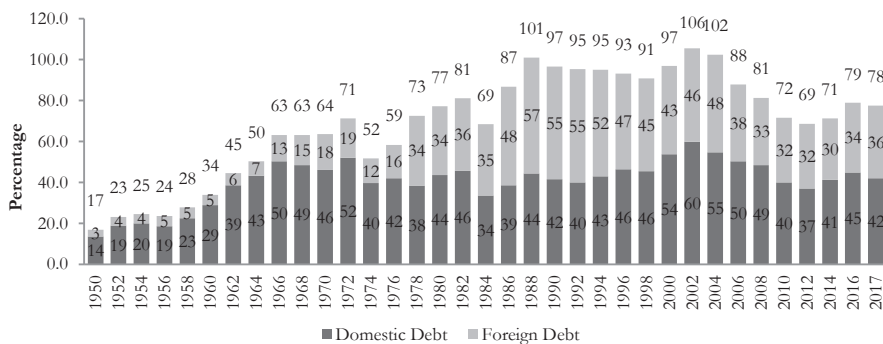


Sources: Central Bank of Sri Lanka and Ministry of Finance

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[3] The debt-to-GDP ratio, which is calculated by using total nominal debt outstanding at the numerator and the size of nominal GDP at the denominator and expressed as a percentage, is a widely used measure for this purpose (Siddiqui 2001).

The foreign debt stock of Sri Lanka consists of both loans obtained with concessional terms as well as with non-concessional or commercial terms. As a percentage of total foreign debt, the concessional financing stood at 97 per cent and 99 per cent in 1995 and 2000, respectively. However, the availability of concessional financing for Sri Lanka turned to a decline rapidly following Sri Lanka's elevation to a lower middle income status in 2010 (International Monetary Fund (IMF) 2011; CBSL Annual Report 2010). Accordingly, the ratio of concessional financing gradually declined to 45 per cent in 2017 from over 90 per cent, which was the case prior to 2007 (Figure 2). This paradigm shift has resulted to increase the interest payments causing high deficits, and consequently further accumulating the debt stock in Sri Lanka.

**Figure 2: Per capita GDP vs foreign debt concessionality**
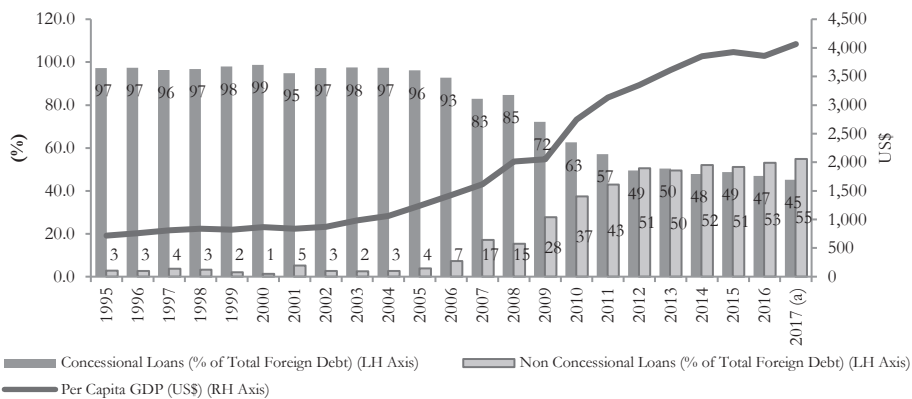


Sources:  Central Bank of Sri Lanka and Ministry of Finance

Although Sri Lanka's debt-to-GDP ratio has declined to some extent over the last decade, it still remains relatively high when compared to other frontier markets/rating peers in the region (IMF 2018) (Table 1).

**Table 1: Government debt to GDP ratio in selected Asian countries**

| Country | 1990 | 2000 | 2010 | 2017 |
|---|---|---|---|---|
| Bangladesh | 51.1 | 31.5 | 36.6 | 33.8 |
| India | 51.5 | 55.8 | 52.2 | 50.3 |
| Maldives | 30.8 | 40.9 | 54.9 | 69.5 |
| Nepal | 52.6 | 57.9 | 34.0 | 26.8 |
| Pakistan | 78.8 | 74.0 | 66.0 | 67.7 |
| **Sri Lanka** | **96.6** | **96.9** | **71.6** | **77.6** |
| Vietnam | NA | 31.4 | 48.1 | 61.5 |

Sources: World Development Indicators, World Bank, World Economic Outlook Database, Reserve Bank of India and State Bank of Pakistan

Various factors have contributed to the debt accumulation in Sri Lanka. Persistently generated low government's tax revenue has adversely contributed towards continuous budget deficits in the country over the past few decades (CBSL Annual Report 2015). The relatively high government expenditure, mainly driven from recurrent expenses have also contributed to increase the budget deficit in the country. Consequently, the high level of government debt of Sri Lanka emanating from continuous high budget deficits have prevailed for several decades, particularly after 1977 (Deyshappriya 2012) (Figure 3). The budget deficit, which was around 5 per cent of GDP on average, during the period 1950-1977 increased to 11 per cent during the period 1978 to 1990, mainly due to the large infrastructure development projects such as Accelerated Mahaweli Development Programme, that were implemented since 1977 (Sanderane 2011). In addition, Sri Lanka's post-civil war mega reconstruction projects, particularly implemented in the affected areas largely utilised the government expenditure contributing to high budget deficits and debt accumulation (Naranpanawa 2017). Further, the inflated government sector as reflected by increasing employees, government institutions and ministries together with various subsidy programmes has also contributed to a large fiscal deficit and thereby higher debt accumulation environment in the country (Sanderathne 2011; Fonseka 2008).

### Figure 3: Government revenue, expenditure, budget deficit & debt to GDP
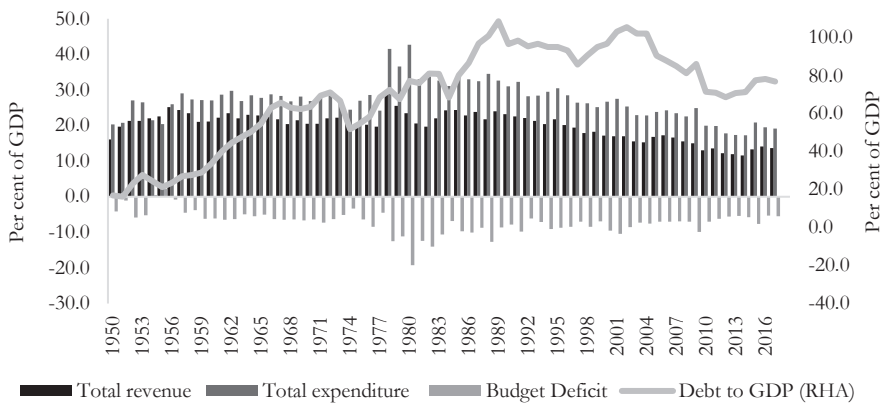


Sources: Central Bank of Sri Lanka and Ministry of Finance

Increasing public debt is believed to have some adverse effects on economic growth in the country causing detrimental impacts on maintaining macroeconomic fundamentals. Accordingly, the sharp increase in cumulative debt stock has resulted in an increase of the debt service payments in the country, largely consuming government's revenue in every year (Table 2). This

would create an upward pressure on the market interest rates occurring the crowding out of private investments (CBSL Annual Report 2017; Deshappriya 2012). The large budget deficits resulted by higher debt service expenditure induce the government to borrow more and more (Deyshappriya 2012), thus creating conditions to expose it towards a 'debt trap' or the 'vicious cycle of debt'. Meanwhile, high debt service payments have exerted some pressure on Balance of Payment (BOP) problems and financial stability through their impact on interest rates, currency over-valuation, and availability of credit and erosion of country's creditworthiness. In addition, high budget deficit and resulted debt levels can make spillover effects to other sectors of the economy, adversely impacting the macroeconomic stability in the country (CBSL Annual Report 2017).

**Table 2: Government debt service payments**

| Item | 1990 | 1997 | 2002 | 2007 | 2012 | 2017(a) |
|------|------|------|------|------|------|---------|
| Debt Service Payments (Rs.bn) | 33 | 93 | 284 | 501 | 1,017 | 1,603 |
| *Amortisation Payment (Rs.bn)* | 12 | 37 | 168 | 318 | 609 | 867 |
| *Interest Payments (Rs.bn)* | 21 | 55 | 117 | 183 | 408 | 736 |
| Debt Service Payments as % of GDP | 10.2 | 10.4 | 18.0 | 14.0 | 13.4 | 12.1 |
| Debt Service Payments as % of Total Revenue | 48.4 | 56.1 | 108.6 | 88.6 | 96.8 | 87.5 |

Source: CBSL Annual Reports
(a) Provisional

Although higher accumulation of public debt has some adverse effects on the economy, in many cases, government financing has been playing a major role in the process of economic development in Sri Lanka as indicated by the improved socio economic and human development indicators (Table 3). With the liberalisation of the economy in 1977, the government borrowings increased significantly, while on the other hand, the investment ratio gradually exceeded 20 per cent of GDP. Consequently, Sri Lanka was able to achieve more than 5 per cent average growth of GDP over the period of 1978- 2017. It is also observed that most of the infrastructure needs such as education, health and social welfare have been upgraded through external borrowings as indicated by improved human development indicators. Other macroeconomic indicators such as per capita GDP and domestic savings also show progress in line with the various infrastructure development projects implemented in the country.

**Table 3: Selected socio-economic indicators for the period 1990-2017**

| Item | 1990 | 1997 | 2002 | 2007 | 2012 | 2017 (a) |
|---|---|---|---|---|---|---|
| GDP Growth (%) | 6.4 | 6.3 | 4.0 | 6.8 | 9.1 | 3.1 |
| Per Capita GDP at Market Price (US$) | 473 | 814 | 870 | 1,634 | 2,922 | 4,065 |
| Unemployment Rate (%) (b) | 15.9 | 10.5 | 8.8 | 6.0 | 4.0 | 4.2 |
| Investment as a % of GDP | 22.2 | 24.4 | 21.2 | 28.0 | 39.1 | 36.5 |
| Domestic Savings as a % of GDP | 14.3 | 17.3 | 14.4 | 17.6 | 27.3 | 29.3 |
| Term of Trade (% change) | -12.5 | 6.8 | 4.6 | -1.0 | 1.5 | 1.2 |
| Human Development Index | 0.626 | 0.662 | 0.697 | 0.731 | 0.757 | 0.766 |

Sources: CBSL Annual Reports and World Development Indicators
(a)     Provisional
(b)     Percentage of labour force

## 3.    Literature survey

### 3.1 Empirical evidence

Egbetunde (2012) points out that public debt would have had a clear positive impact on economic growth in Nigeria if the government had utilised such borrowings for productive investment purposes rather than personal benefit schemes. Time series data over the period 1970-2010 and a standard VAR model has been used to estimate the results. Similar results are observed by Victor and Christoper (2016), examining the causal relationship between public debt and economic growth in Ghana covering the period from 1970 to 2012. Johanson Cointegration with VECM technique were employed to estimate the relevant regressions. Using a Two Stage Least Square (TSLS) regression technique, Saifuddin (2016) comes to the same conclusion in the context of Bangladesh during 1974-2014. Another positive and significant relationship between public debt and economic growth is suggested by Mohanty and Mishra (2016) for 14 major States in India using a cointegration in panel data. This study also found bidirectional causality among public debt and economic growth over the period 1980-2013. Employing an OLS method and time series data for the period 1988 to 2013, Ntshakala (2014) suggests similar positive results for Swaziland. Wibowo (2017) evaluates the correlation between public debt and economic growth in Southeast countries using annual data from 2006 to 2015 and VAR approach. It is concluded that public debt has a significant positive influence on economic growth in these countries. In contrast, Mhlaba and Phiri (2017) find that public debt negatively affects on economic growth in the long run in South African countries. However, in the short run, it is revealed that public debt positively influences economic growth in these countries. They estimate the outcomes using a ARDL model including cointegration and VECM techniques with a sub-samples dataset covering the period from 2002:q2 to 2016:q4. Employing OLS approach to cointegration technique, Atique and Malik (2012) conclude a study suggesting that both domestic and external debt negatively

effect on the economic growth in Pakistan for the period 1980-2019. In this case, the negative impact of external debt is much stronger than the domestic impact. Akram (2011) also comes to the same conclusion about Pakistan reporting that both foreign and domestic public debt have a significant and negative impact on economic growth and investment. The respective results were estimated applying an ARDL model and using time series data for the period of 1972-2009. Akram (2016) adds another study to the literature investigating the consequences of public debt on economic growth and poverty in South Asian countries for the period 1975 to 2010. In this case, he finds mixed results with regard to the effect of foreign and domestic debt on economic growth and poverty. Pegkas (2018), focusing annual data over the period 1970 -2016 and using ARDL and VECM techniques reveals a significant and long run negative association between public debt and economic growth in Greece, particularly after the year 2000. Munir (2015) investigates a nonlinear relationship between public debt and economic growth for South Asian countries during 1992-2013. He applies a panel fixed effects estimation procedure to approximate the outcomes and finds that public debt positively affects economic growth up to a certain level and thereafter it negatively affects economic growth. It also reveals the basic channels through which public debt affect economic growth, including private investment, public investment and factor of productivity. Similarly, Saeed and Islam (2016) explore a significant and positive nonlinear association between public debt and economic growth in selected Asian countries including Sri Lanka. This has been conducted under the endogeneity and non-linearity covering the period from 1980 to 2014. Using the data for three Asian countries during 1975 -1998, Siddiqui and Malik (2001) estimate a growth model to find the relationship among foreign debt and economic growth with its nonlinearities. In contrast to their expected results, the study suggests a positive and significant impact of foreign debt on economic growth among these countries. Highlighting a nonlinear association, Elements et. al, (2003) point out that higher external debt beyond 50 per cent of GDP causes to reduce the economic growth in low income countries during 1970-1999. They also suggest that economic growth affects public debt indirectly thorough a channel of public investment using fixed effects and GMM techniques. Similarly, Mencingen, Aristovnik and Verbic (2014) also propose a nonlinear relationship for 25 European Union (EU) countries over the period of 1980-2010. The study reveals that the critical threshold level is in the range of 80-90 per cent for old member countries, while it is 53-54 per cent for new member countries. Differently, Panizza et, al, (2012) suggest that there is no causal link between public debt and economic growth in a sample of 17 OECD countries by using an instrumental variable approach.

With regard to the Sri Lankan context, Kumara and Cooray (2013) assess the relationship between public debt and economic growth, while examining the optimal threshold rate of debt sustainable for Sri Lanka covering the period of 1960-2010. The study reveals that there is a nonlinear relationship between the public debt and GDP per capita growth in Sri Lanka and the optimal threshold level for public debt is 59.42 per cent of GDP. Using two step model

specifications, Akram (2017) explores a direct positive relationship between the public debt and economic growth in Sri Lanka, while observing a significant positive causality between public debt and investment. For the study, time series data for the period of 1975-2014 and ARDL model including VECM techniques were employed. In contrast, he finds a negative relationship between debt service payments and economic growth, reflecting a crowd out investment in the economy. Reaching a similar conclusion, Aslam (2016) finds a significant long run positive relationship between budget deficit and economic growth in Sri Lanka for the period of 1959-2013. The respective outcomes are estimated using a Johanson Cointegration maximum likelihood technique with VECM model. Another Sri Lankan university study has been conducted by Silva and Perera (2015), indicating a positive association between public debt and gross domestic product in Sri Lanka during 2000-2014. In contrast, Fernando et. al, (2017) conducted a comprehensive analysis and found that the low quality of borrowings from commercial sources is a key factor in determining the impact of debt on economic growth and it showed a negative effect on economic growth in Sri Lanka. This is revealed using an ARDL model and annual data from 1960 to 2015. Meanwhile, using a Johansen cointegration approach followed by VECM, Attapattu and Padmasiri (2018) conclude that public debt has a long run negative association with economic growth in Sri Lanka during 1977-2012. Similarly, Ekanayake (2011) concludes that one standard deviation growth shock (positive) will reduce the debt to GDP ratio by 2.4 per cent by 2015 in Sri Lanka.

## 3.2 Theoretical models

Public debt is an accumulated value of borrowings used to finance the government's budget deficit (Wibowo 2017). This implies that public debt plays a major role in fiscal operations, particularly in determining the government's expenditure. The role of public debt in an economy has been discussed in several theoretical models (Akram 2017). However, based on economic effects of budget deficit, these theoretical models can be broadly divided into three schools of thought namely; Neoclassical, Keynesian and Ricardian (Bernheim 1989).

### 3.2.1 Neoclassical Growth Model

According to the neoclassical growth model developed by Solow (1956), economic growth can be achieved by increasing savings and investments. These activities need to be financed through internal sources such as taxes and non tax revenue. However, if the tax and non tax revenue (domestic savings), particularly in developing countries are not sufficient to cover the essential investments that are required for economic development, they have to finance such investments using government borrowings. This implies that the utilisation of such borrowings for productive investments would enhance economic activities, reflecting the direct impact of public debt on economic growth. On the other hand, the decline in domestic savings will lead to an increase of interest rates, resulting in a crowding out private investment in the economy. The theory also argues that higher debt service payments, emanating from

large foreign debt accumulation would create crowding out government expenditure, indicating the negative correlation between public debt and economic growth.

### 3.2.2 Keynesian Growth Model

According to the Keynesian model as highlighted by Bernheim (1989), increasing government expenditure and expansionary fiscal policies are considered main determinants in the process of economic growth. This indicates that increasing government expenditure and decreasing taxes will enhance the aggregate demand, and thereby the economic growth. For instance, an increase in budget deficit by 1 rupee will expand the output by the inverse of the marginal propensity to save. On the other hand, expansion of the output will raise the money demand, exerting upward pressure on the market interest rates and thereby creating crowding out private investments in the economy. In contrast, Keynesian theory also emphasises the importance of a surplus budget as it is supportive to decrease the government borrowings. Therefore, the Keynesian paradigm focuses on flexible views concerning the short run effect.

### 3.2.3 Classical Growth Model

According to the Ricardian theory, governments finance their expenditure using either tax income or borrowings from external and internal sources. If governments use borrowings to finance their expenditure, they will have to repay the amortisation and interest payments on borrowed funds by increasing future taxes on the public. This implies that the net impact of borrowings is almost similar to financing the government expenditure through taxes, suggesting that there is no impact on the aggregate demand. Empirical evidence has also argued that investors are expecting an increase tax rates in the future with the higher debt accumulation. This investor expectation leads to slow down further investments in the economy, reflecting its negative impact on economic growth (Munir 2015).

### 3.3 Theories of Debt and Growth

In the literature, three important theories discuss about the impact of public debt on economic growth (Ngugi 2016).

### 3.3.1 Crowding in Effect

Theoretical arguments suggest that if a government utilises its borrowed funds in productive investment purposes effectively and in an efficient manner, that will lead to enhance a country's economic growth (Mhlaba 2017). However, if a country heavily relies on government borrowings, that will result to increase the debt accumulation stock, creating various fiscal risks.

### 3.3.2 Crowding out Effect

It is argued that if a government utilises its borrowings largely for unproductive purposes that will prevent the sufficient investments in the country, it would lead to a slowdown in the economic growth. In such a situation, increasing public debt is known as a barometer of loose fiscal policy (Kobayashi 2015). The theory also argues that the crowding out investment occurs mainly due to a rise in market real interest rates. Further, the literature discusses this theory as borrowings increase the current consumption shifting the tax burden for the future generations (Ngugi 2016). Higher current consumption, on the other hand, reduces the domestic savings, exerting upward pressure on the market interest rates. This in turn causes to reduce the private investments, reflecting the crowding out impact in the economy.

### 3.3.3 Debt Overhang Theory

According to the debt overhang theory developed by Krugman (1988), foreign debt has a positive impact on economic growth until a certain level, and beyond that level, the marginal impact of an additional debt on economic growth will reduce. This is because continuous increase in debt stock could be larger than the country's repayment ability in the future. This is likely to increase the expected debt service costs discouraging further investments and adversely affecting the economic growth (Mhlaba 2017). On the other hand, higher interest payments on foreign debt will increase the budget deficit creating a lower national savings environment in the country. Consequently, high interest rates can drive up crowding out the resources available for private investments, particularly in the areas of infrastructure development, education, health and other social activities. Moreover, the possibility of default of the debt servicing will also create uncertainty among the investors, adversely affecting the stability of the future inflows (Akram 2017). This will reduce the productivity of capital and thereby economic growth.

### 3.4 Theoretical Framework

In this section, a simple model is developed to show the macroeconomic relationship between economic growth and public debt following the neoclassical growth model and the previous research studies (eg., Nantwi 2016; Erickson 2016). The neoclassical growth model (Solow) argues that the increasing government expenditure is believed to be an important investment in human capital such as education, health and infrastructure. Considering the fact that, if the government debt is raised for financing such productive investments, it is argued that the government's borrowings will increase the output mainly through enhanced capital (K), labour (L), technology (A) and other factors (N). This relationship can be shown by an aggregate production function as follows;

$$Y_t = Af(K_t, L_t, N_t) \qquad (1)$$

where, $Y_t$ is growth of aggregate output (GDP) at time $t$, $A$ is level of technology, $K_t$ is stock of capital at time $t$, $L_t$ is labour force at time $t$ and $N_t$ is the vector of other factors including public debt, that affected on economic growth at time $t$.

In order to express the equation (1) in a growth terms, total derivatives are taken and the respective equation is given by the following form.

$$\frac{\partial Y_t}{Y_t} = \frac{\partial A_t}{A_t} + A \cdot \frac{\partial Y_t}{\partial K_t} \cdot \frac{\partial K_t}{Y_t} + A \cdot \frac{\partial Y_t}{\partial L_t} \cdot \frac{\partial L_t}{Y_t} + A \cdot \frac{\partial Y_t}{\partial N_t} \cdot \frac{\partial N_t}{Y_t}$$

or $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ (2)

$$\frac{\partial Y_t}{Y_t} = \frac{\partial A_t}{A_t} + A \cdot \frac{\partial Y_t}{I_t} \cdot \frac{I_t}{Y_t} + A \cdot \frac{\partial Y_t}{\partial L_t} \cdot \frac{\partial L_t}{Y_t} + A \cdot \frac{\partial Y_t}{\partial N_t} \cdot \frac{fX_{it}}{Y_t}$$

where, $\partial K_t = I_t$ (Changes in capital stock is equivalent to the change in gross domestic capital formation, $I$, in each year).

$\partial N_t = fX_{it}$ (Change in other independent variables including debt variables (vector), which is assumed to be equivalent to the value of each variable, $i$).

Incorporating above arguments, a new equation can be obtained as follows;

$$\frac{\partial Y_t}{Y_t} = \frac{\partial A}{A} + \left\{ A \cdot \frac{\partial Y_t}{\partial I_t} \cdot \frac{I_t}{Y_t} \right\} \cdot \frac{\partial I_t}{I_t} + \left\{ A \cdot \frac{\partial Y_t}{\partial L_t} \cdot \frac{L_t}{Y_t} \right\} \cdot \frac{\partial L_t}{L_t} + \left\{ A \cdot \frac{\partial Y_t}{\partial Ni_t} \right\} \cdot \frac{\partial fX_{it}}{Y_t} \qquad (3)$$

We can express the equation (3) in a simple way as follows;

$$\frac{\Delta Y_t}{Y_t} = \alpha_0 + \alpha_1 \frac{\Delta I_t}{I_t} + \alpha_2 \frac{\Delta L_t}{L_t} + \alpha_{3i} \cdot \frac{fX_{it}}{Y_t} \qquad (4)$$

Where;

$$\alpha_0 = \frac{\partial A}{A}, \qquad \alpha_1 = A \cdot \frac{\partial Y_t}{\partial I_t} \cdot \frac{I_t}{Y_t}, \qquad \alpha_2 = A \cdot \frac{\partial Y_t}{\partial L_t} \cdot \frac{L_t}{Y_t}, \quad \alpha_{3i} = A \cdot \frac{\partial Y_t}{\partial Ni_t}$$

For the estimation purposes, the growth equation (4) can be expressed in the reduced vector form (Clements (2003)] as;

$$G_t = \alpha_0 + \alpha_1 I_t + \alpha_2 L_t + \sum_{i=1}^{n} \alpha_{3i} fX_{it} + \mu_t \tag{5}$$

where, $G_t$ is GDP growth rate at time $t$, $I_t$ is growth of investment to GDP ratio at time $t$, $L_t$ is growth of labour force, $fX_{it}$ is a vector of other independent variables including public debt ratios, which measured as a percentage of GDP, $n$ represents the number of variables, $\alpha_1$ is elasticity of GDP growth with respect to the change in investment, $\alpha_2$ is elasticity of GDP growth with respect to change in labour force, $\alpha_{3i}$ is elasticity of GDP growth with respect to change in other independent variables including public debt ratios and $\mu_t$ is the error term of the model.

Extending the growth equation (5), we can obtain another reduced vector form (Akram 2011) to capture the effect of public debt on investment, is given by;

$$I_t = \alpha_0 + \alpha_1 G_t + \alpha_2 L_t + \sum_{i=1}^{n} \alpha_{3i} fX_{it} + \mu_t \tag{6}$$

where, $\alpha_1$ is elasticity of investment growth with respect to change in GDP, $\alpha_2$ is elasticity of investment growth with respect to change in other independent variables including public debt ratios.

## 4. Data and methodology

### 4.1 Choice of methodology

The study aims to analyse both long run and short run impacts of public debt on economic growth. Therefore, it is more appropriate to use a VECM approach specified under the VAR framework with cointegration technique. This procedure determines both long run and short run effects at the same time, detecting cointergrating vectors. In a situation, that series existence cointergration, using OLS may give spurious results. Further, remaining rich literature on the utilisation of this technique also induced the author to use this method.

### 4.2 Data description

The study is carried out using annual time series data for Sri Lanka covering the period from 1977 to 2017. The main data sources are annual reports of the Central Bank of Sri Lanka (CBSL) and the Ministry of Finance (MOF). All variables used in the study are transformed into their natural logs with the view of eliminating serial correlations and multicollinearity issues (Mohanty 2016). More details about the all variables are summarised in Table 4.

## Table 4: Details of variables

| Name of Variable | Definition of Variable | Data Source |
|---|---|---|
| Per Capita GDP ($PGDP$) | GDP per capita in current market price (Rs.). This is used as a proxy for GDP growth. | CBSL |
| Private Investment ($INV_p$) | Private gross capital formation as a % GDP | CBSL |
| Public Investment ($INV_g$) | Public gross capital formation as a % of GDP | CBSL & MOF |
| Public Domestic Debt ($PDD$) | Government domestic debt as a % of GDP | CBSL |
| Public Foreign Debt ($PFD$) | Government foreign debt as a % of GDP | CBSL |
| Total Public Debt ($PTD$) | Total government debt as a % of GDP | CBSL |
| Debt Service Payments ($DSP$) | Government debt service payment as a % of GDP | CBSL |
| Openness ($OPN$) | (Export +Import)/GDP*100 | CBSL |
| Population Growth ($POP$) | Population growth rate. This is used as a proxy for labour force in the country. | CBSL |
| Domestic Savings ($DSV$) | Domestic saving as a % of GDP | CBSL |
| Inflation ($INF$) | Annual consumer price index | CBSL |
| Exchange Rate ($EXR$) | Average annual exchange rate | CBSL |

## 4.3 Model specification

In terms of the model specification, the study specifies two models: growth model and investment model following related literature (eg., Element 2003; Chongo 2013; Nisma 2015; Akram 2016). The growth model is used to assess the direct impact of public debt along with other independent variables on economic growth. The investment model is applied to examine the effect of public debt along with other independent variables on investment. This model facilitates the finding of the basic channel through which public debt affects on economic growth. Hence, the investment model explains the indirect relationship between public debt and economic growth.

## 4.3.1 Growth model

Based on the equation (5) described in the section three, the econometric growth model can be specified as;

$$PGDP_t = \alpha_0 + \alpha_1 INV_{pt} + \alpha_2 INV_{gt} + \alpha_3 PDD_t + \alpha_4 PFD_t + \alpha_5 DSP_t + \alpha_6 OPN_t$$
$$+ \ \alpha_7 POP_t + \mu_{1t} \tag{7}$$

where, $PGDP_t$ is the per capita GDP at time $t$, $INV_{pt}$ is the private investments at time $t$, $INV_{gt}$ is the public investments at time $t$, $PDD_t$ is the public domestic debt at time $t$, $PFD_t$ is the public foreign debt at time $t$, $DSP_t$ is debt service payments at time $t$, $OPN_t$ is openness at time $t$, $POP_t$ is population growth at time $t$ and $\mu_{1t}$ represents the error term of the growth model. In the model, $PGDP_t$ is used as the dependent variable, while all other variables represent the independent variables. In this case, all variables except debt service payments are expected to have a positive correlation with per capita GDP.

Following the Johansen and Juselius (1990/1991), the mathematical growth equation (7) is expressed in its log form and specified in the VAR model for multivariate cointegration test as follows:

$$lnPGDP_t = \alpha_0 + \alpha_1 lnINV_{pt} + \alpha_2 lnINV_{gt} + \alpha_3 lnPDD_t + \alpha_4 lnPFD_t + \alpha_5 lnDSP_t +$$
$$\alpha_6 lnOPN_t + \alpha_7 lnPOP_t + \mu_{1t} \tag{8}$$

The equation (8) is now rewritten in a VECM form as follows;

$$\Delta lnPGDP_t = \alpha_1 \Delta lnINV_{pt-1} + \alpha_2 \Delta lnINV_{gt-1} + \alpha_3 \Delta lnPDD_{t-1} + \alpha_4 \Delta lnPFD_{t-1} +$$
$$\alpha_5 \Delta lnDSP_{t-1} + \alpha_6 \Delta lnOPN_{t-1} + \alpha_7 \Delta lnPOP_{t-1} + \xi_{t-1} + \mu_{1t} \tag{9}$$

where, $\Delta$ represents the difference operator and $\xi_{t-1}$ represents the lagged value of the Error Correction Term ($ECT$) derived from long run cointegration vector. This allows to determine the short run dynamics of the growth model.

### 4.3.2 Investment model

Based on the equation (6), the econometric model for investment can be specified in the following form[4].

$$INV_t = \alpha_0 + \alpha_1 PGDP_t + \alpha_2 TPD_t + \alpha_3 DSP_t + \alpha_4 DSV_t + \alpha_5 OPN_t + \alpha_6 INF_t +$$
$$\alpha_7 EXR_t + \mu_{2t} \tag{10}$$

where, $INV_t$ is total investment (private investment + public investment) at time $t$, $PGDP_t$ is the per capita GDP at time $t$, $TPD_t$ is the total public debt (domestic + foreign) at time $t$, $DSP_t$ is debt service payments at time $t$, $DSV_t$ is domestic savings at time $t$, $OPN_t$ is openness

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[4] In this case, labour is replaced by domestic savings to make the estimation easier.

at time $t$, $INF_t$ is inflation at time $t$, $EXR_t$ is average annual exchange rate at time $t$ and $\mu_{2t}$ represents the error term of the investment model. In this model, $INV_t$ is the dependent variable, while all other variables including public debt variables are represented by the independent variables. In many cases in related literature, different variables have been used to estimate the investment model compared to the growth model (eg., Saifuddin 2016; Riffat Munir 2015; Chongo 2013; Akram 2010). In this case, $PGDP, TPD, DSV, OPN$ are expected to have positive coefficients, while $DSP, INF, EXR$ are expected to show negative coefficients.

The mathematical equation (10) can be expressed in its natural log form under the following VAR process:

$$lnINV_t = \alpha_0 + \alpha_1 lnPGDP_t + \alpha_2 lnTPD_t + \alpha_3 lnDSP_t + \alpha_4 lnDSV_t +$$
$$\alpha_5 lnOPN_t + \alpha_6 lnINF_t + \alpha_7 lnEXR_t + \mu_{2t} \qquad (11)$$

The equation (11) is rewritten in a VECM form as follows;

$$\Delta lnINV_t = \alpha_1 \Delta lnPGDP_{t-1} + \alpha_2 \Delta lnTPD_{t-1} + \alpha_3 \Delta lnDSP_{t-1} + \alpha_4 \Delta lnDSV_{t-1} +$$
$$\alpha_5 \Delta lnOPN_{t-1} + \alpha_6 \Delta lnINF_{t-1} + \alpha_7 \Delta lnEXR_{t-1} + \xi_{t-1} + \mu_{2t} \qquad (12)$$

### 4.4 Econometric procedures

Several statistical methods and econometrics tests were carried out to estimate both the long run and short run relationships among the variables of the specified two models.

### 4.4.1 Unit Root tests

In order to test the cointegration among variables, it is required to check the stationarity of each variable as a preliminary step (Edbetunde 2012; Christoper 2016; Aslam 2016). Hence, the stationarity of the time series data was tested using Augmented Dickey-Fuller (1979) and Phillip-Perron (1988) unit root tests. In the literature, these two procedures are well established to determine the characteristics of individual series of the variables.

### 4.4.2 Augmented Dickey-Fuller (ADF)

The ADF test developed by Dickey and Fuller is the most popular technique in the literature for analyzing time series data. The respective regression equation of the ADF unit root is given by the following form.

$$\Delta Y_t = \beta_1 + \beta_2 + \delta Y_{t-1} + \sum \delta_i \Delta Y_{t-1} + \mu_t \qquad (13)$$

where, $Y$ represents the relevant variable in the estimation procedure at time $t$, $\Delta$ is first difference operator, $\mu_t$ is a pure white noise error term with zero value of mean and constant variance. In the equation, it is assumed that the error term $\mu_t$ is serially uncorrelated and using the AR (P) process.

### 4.4.3 Phillips – Perron (PP)

PP unit root testing approach was developed by Phillips and Perron in 1988. In the literature, this approach is also much popular in analyzing the time series data. The following form is used to test the stationarity of the variables (Aslam 2016).

$$\Delta Y_t = \beta' D_t + \pi Y_{t-1} + u_t \qquad (14)$$

where, $u_t$ is $I(0)$ and may be heteroskedasticity.

The hypothesis for the ADF and PP are $H_0$ = The Null hypothesis has unit roots and $H_1$ = The Alternative hypothesis has no unit roots (stationary).

### 4.4.4 Johansen and Juselius Cointegration test:

After determining the stationarity of each variable, the Johansen test of multivariate cointegration method, which was developed by Johansen (1991) and Juselius (1990) was applied to test the possibility of having cointegration among 1(I) variables. By testing the cointegration, one can ascertain a stable long run association between the variables (Mohanty 2016; Wibowo 2017; Atapattu 2018). The Johansen cointegration tests are likelihood ratio tests and there are two different test statistics to determine the number of cointegration vectors, including the Trace test and Maximum Eigenvalue test. The trace test and Maximum Eigenvalue test statistics are computed using the following equations (15) and (16), respectively.

$$J_{trace} = -T \sum_{i=r+1}^{n} ln\left(1 - \hat{\lambda}_i\right) \qquad (15)$$

$$J_{max} = -Tln\left(1 - \hat{\lambda}_{r+1}\right) \qquad (16)$$

where, $T$ is the sample size and $\lambda$ is the Maximum Eigenvalue. The Trace statistics examine the null hypothesis of $r$ cointegrating relations opposed to alternative hypothesis of $n$

cointegrating vectors. In this case, $n$ is the number of variables in the system for $r = 0,1,2 \dots n - 1$. The Maximum Eigenvalue statistics investigate the null hypothesis of $r$ cointegrating vectors against a specific alternative hypothesis of $(r + 1)$ cointegrating vectors for $r = 0,1,2 \dots n - 1$.

### 4.4.5 Vector Error Correction Model (VECM)

Once examined the cointegrating relationship between series, which implies that there exists a long run equilibrium relationship between the variables, the short run causal relationship of the cointegrated series is determined by estimating a VECM. The variables in VECM are expressed in the first difference. Accordingly, the general regression equation of VECM takes the following form.

$$\Delta Y_t = \alpha_1 + P_1 e_1 + \sum_{i=0}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-i} + \sum_{i=0}^{n} \gamma_i Z_{t-i}$$

(17)

$$\Delta X_t = \alpha_2 + P_2 e_{i-1} + \sum_{i=0}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-i} + \sum_{i=0}^{n} \gamma_i Z_{t-i}$$

where, $\alpha_1$ and $\alpha_2$ are constant. The cointegration rank in VECM determines the number of distinct cointegrating vectors. The Error Correction Term (ECT) shows the speed of adjustment of the state of the equilibrium and it is expected to be negative and significant. A negative and significant coefficient of the ECT indicates that there exists a stable long run relationship between series caused by any short run fluctuations among the variables.

## 5. Empirical results

### 5.1 Descriptive analysis of statistics

Analysing the descriptive statistics of each variable is useful to understand the nature of the distribution of such variables. According to the descriptive statistics (Table A1), low standard deviations (SDs) of all variables indicate the favorable dispersion of the distributions. Relatively low coefficients of skewness and kurtosis show the approximate normality distribution of each variable. Further, the variation between maximum and minimum of each variable is quite favorable, while the ratio of mean to median is closer to 1. All these indicate that data can be used effectively to continue the estimations.

### 5.2 Results of Unit Root tests

It is necessary to test the unit roots of each variable prior to determining the cointegrations among such variables as most of time series data are non-stationary. Non-stationary variables may tend to provide spurious regression results without any economic meaning (Attapattu 2018). Hence, the verification of the stationarity of each variable relating to both models was tested by using unit root tests as described in section four. The results of unit roots of all variables are summarised in Table 5.

The results clearly indicate that all variables are stationary at first differences. However, population growth and exchange rate are stationary at both levels and first difference. Although population growth and exchange rate, which belong to two different models are stationary at both levels and first differences, the study can apply cointegration and VECM techniques to estimate the specified two models as most of the series are integrated of order one I (1) (Nantwi 2017; Akram 2017; Pegkas 2018). In addition to these standard unit root tests, a "Breakpoint Unit Root Test" was also carried out to verify the stationarity of each variable and showed similar results (Table A2). The results of the above unit root tests imply that there is a long run equilibrium relationship among the series without any possibility of having spurious regressions.

**Table 5: Unit root analysis for all log variables**

|  | Augmented Dickey Fuller (ADF) | | Phillip –Perron (PP) | |
|---|---|---|---|---|
|  | Level | First difference | Level | First difference |
| $lnPGDP$ | -1.678588 | 11.78755* | -1.432146 | -5.141078* |
| $lnINV$ | -0.510917 | -6.843721* | -3.530147 | -8.331957* |
| $lnINV_g$ | -2.202477 | -4.021255* | -1.784306 | -8.262733* |
| $lnINV_p$ | 0.194805 | -6.306224* | -2.114215 | -9.768286* |
| $lnPDD$ | -2.107494 | -6.318956* | -2.139102 | -6.319355* |
| $lnPFD$ | -1.695165 | -7.255984* | -1.828098 | -7.136285* |
| $lnTPD$ | -2.267403 | -7.021403* | -2.022429 | -7.004712* |
| $lnDSP$ | -2.129477 | -10.05310* | -2.458160 | -10.25443* |
| $lnOPN$ | -1.944482 | -9.022518* | -2.310843 | -9.200885* |
| $lnDSV$ | -1.446786 | -7.210028* | -1.407411 | -7.340134* |
| $lnPOP$ | -7.005876* | -14.28309* | -6.965996* | -32.02282* |
| $lnINF$ | -1.839019 | -7.922255* | -2.887262 | -7.422694* |
| $lnECR$ | -3.505032* | -13.13939* | -3.701159* | -11.42282* |

| | Critical Values | | | |
|---|---|---|---|---|
| 1% Critical Value | - 3.605593 | - 3.615588 | - 3.605593 | - 3.610453 |
| 5% Critical Value | - 2.936942 | - 2.941145 | - 2.936942 | - 2.938987 |
| 10% Critical Value | - 2.606857 | - 2.609066 | - 2.606857 | - 2.607932 |

* indicates significance at 1%, 5% and 10%.

### 5.3 Selection of optimal lag length:

The optimal lag length used to estimate the specified models is 2. This was selected using the Akaike Information Criterion (AIC), Final Predictor Error (FPE) and Sequential Modified LR tests. This selection is also consistent with the arguments made by Pesaran et al. (2001) and Akram (2016). They suggest that maximum lag length 2 is more appropriate for the studies that have been conducted using annual data with short data observations. In this study, annual data and only 41 observations with seven parameters for each model are used.

### 5.4 Results of cointegration tests, long run and short run equilibrium relationship of the growth model

### 5.4.1 Cointegration results:

Assuming a linear deterministic trend, the long run effect of public debt on economic growth was tested using a cointegration procedure as discussed in the Section four. The results of the cointegration rank tests; Trace statistics and Maximum Eigen Value statistics, respectively suggest that there exist four and three long run cointegration equilibrium relationship at 5 per cent significant level (Tables 6 and 7). This implies that the hypothesis of no cointegration among variables in the growth model is rejected, indicating a stable long run relationship between economic growth and public debt along with other independent variables.

**Table 6: Johansen cointegration rank test results (trace)**

| Cointegration Relations Null Hypothesis | Eigen Value | Trace Statistics | Critical Value at 5% level | Probability Value** |
|---|---|---|---|---|
| None * | 0.903294 | 265.9264 | 159.5297 | 0.0000 |
| At most 1* | 0.781470 | 174.8195 | 125.6154 | 0.0000 |
| At most 2* | 0.658888 | 115.5070 | 95.75366 | 0.0011 |
| At most 3* | 0.545693 | 73.56079 | 69.81889 | 0.0244 |
| At most 4 | 0.320277 | 42.79052 | 47.85613 | 0.1377 |
| At most 5 | 0.312478 | 27.73382 | 29.79707 | 0.0849 |
| At most 6 | 0.198913 | 13.12203 | 15.49471 | 0.1104 |
| At most 7* | 0.108345 | 4.472361 | 3.841466 | 0.0344 |

Trace test indicates 4 cointegrating eqn (s) at the 0.05 level. * denotes rejection of the hypothesis at the 0.005 level.
** Mackinnon-Haug-Michelis (1999) p-values.

## Table 7: Johansen cointegration rank test results (maximum eigen value)

| Cointegration Relations Null Hypothesis | Eigen Value | Max-Eigen Statistic | Critical Value at 5% level | Probability Value** |
|---|---|---|---|---|
| None * | 0.903294 | 91.10694 | 52.36261 | 0.0000 |
| At most 1* | 0.781470 | 59.31246 | 46.23142 | 0.0012 |
| At most 2* | 0.658888 | 41.94622 | 40.07757 | 0.0304 |
| At most 3 | 0.545693 | 30.77027 | 33.87687 | 0.1124 |
| At most 4 | 0.320277 | 15.05670 | 27.58434 | 0.7437 |
| At most 5 | 0.312478 | 14.61179 | 21.13162 | 0.3170 |
| At most 6 | 0.198913 | 8.649665 | 14.26460 | 0.3165 |
| At most 7* | 0.108345 | 4.472361 | 3.841466 | 0.0344 |

Max-eigenvale test indicates 3 cointegrating eqn (s) at the 0.05 level. * denotes rejection of the hypothesis at the 0.005 level. ** Mackinnon-Haug-Michelis (1999) p-values.

### 5.4.2 Long Run Relationship

As indicated by the cointegration results, it was found that there is a stable long run association between economic growth and public debt along with other control variables. The estimated long run model of cointegration and corresponding long run coefficients obtained from the VECM are reported in Table 8.

## Table 8: Cointegration coefficients from VECM

| Regressor | Coefficient | Standard Error | T Ratio |
|---|---|---|---|
| $lnPGDP$ | 1.000000 | | |
| $lnINV_p$ | 15.95286 | (3.27731) | [2.23494] * |
| $lnINV_g$ | 13.00860 | (5.82057) | [2.23494] * |
| $lnPDD$ | 29.16112 | (4.12455) | [7.07013] * |
| $lnPFD$ | 18.59824 | (2.77315) | [6.70654] * |
| $lnDSP$ | -3.390809 | (2.93169) | [-1.85661] ** |
| $lnOPN$ | 2.355765 | (8.09584) | [0.29098] |
| $lnPOP$ | -7.954618 | (2.73388) | [-2.90964] * |

* and ** indicate significance at 5% and 10 % levels, respectively.

According to the results, long run normalised cointegrating coefficients of both domestic and foreign public debt are positive and statistically significant at 5 per cent level. This implies that in the long run, both domestic and foreign public debt positively and significantly influence economic growth in Sri Lanka. During the period under consideration, successive

governments have borrowed funds significantly to finance the large capital expenditure programmes in the country (Weerasinghe 2010). Some of these capital projects include agriculture related infrastructure development projects, establishment of 200 garment factories (1990), Accelerated Mahaveli programe since 1976, irrigation development projects, Norochcholai Coal Power project (2011), Southern Expressway (2011), Medawachiya-Madu railway development project (2013), Magam Ruhunupura port development project (2010), Mattala International Air Port (2013) and various housing projects. Thus, it could be argued that public debt has positively contributed towards economic growth in the country during the period under review.

Moreover, this positive correlation between public debt and economic growth is supported by a majority of Sri Lankan related studies conducted by Akram (2016), Kumara and Cooray (2013), Aslam (2016) and Silva and Perera (2017). On the global front, the literature has found many positive long run results between public debt and economic growth (eg., Victor 2016; Munir 2015; Wibowo 2017; Ntshakala 2014). This positive conclusion is further affirmed by the results estimated from the investment model of this study. That is, public debt positively influences investment and thereby economic growth. In contrast to the above outcome, Attapattu and Padmasiri (2018) and Ekanayake (2011) have proposed a negative association between public debt and economic growth in Sri Lankan.

Debt service payment shows a negative long run impact on economic growth at 10 per cent significant level. It is inferred that this negative association can be occurred due to crowding out investment emanated from high accumulation of foreign and domestic debt. This conclusion is similar to the findings of the study on Sri Lanka conducted by Akram in 2017. However, the overall impact of increasing public debt on economic growth indicates a favorable sign as the negative impact of crowding out investment is outweighed by the positive effect of total public debt on economic growth.

As expected, both public and private investments show a positive and significant long run impact on economic growth, reflecting an increase in production capacity with enhanced capital formation. These findings are also consistent with the theoretical evidence and most empirical evidence. The results of the openness reveal an insignificant positive link to economic growth in the long run. This result is supported by some previous studies (Elements 2003; Zeaud 2014; Akram 2016). In contrast to envisaged outcomes, population growth shows a negative long run impact on economic growth at 5 per cent significant level. This proposition is consistent with various studies (Siddiqui 2001; Zeaud 2014; Riffat 2015; Akram 2017). They argue that the population growth can have both positive and negative impacts on economic growth based on which side of the economy it affects. For instance, higher population in South Asian countries leads to increase poverty, creating more burdens in their economies. Further, higher population growth may hinder economic growth and cause to reduce productivity of these countries.

As reported in Table 9, the significant ECT further confirms above discussed long run cointegration relationships among variables. The ECT, which measures the speed of adjustment of disequilibrium, is significant with negative signs (- 0.08100). The coefficient of the ECT also suggests that, the previous year's disequilibrium in per capita GDP adjusts by 8.1 per cent in the current year to long run equilibrium.

### 5.4.3 Results of VECM and short run relationship

The short run dynamic relationships among variables associated with the long run estimates were assessed by applying a VECM. The short run results of the VECM are tabulated in Table 9.

According to the short run results, one period lagged of public domestic debt has a negative correlation to per capita GDP at 5 per cent significant level. This conclusion is consistent with a Sri Lankan study conducted by Akram (2017). Meanwhile, one period lagged private investment and two periods lagged public investment show a statistically significant positive effect on economic growth parallel to the long run impact. This is also consistent with the Keynesian theory and some empirical evidence. However, all other variables observed that there exist insignificant short run effects on economic growth.

**Table 9: VECM regression results of the growth model**

Dependent Variable: $lnPGDP$

| | Coefficient | Standard Error | T Ratio | Probability |
|---|---|---|---|---|
| $ECT *$ | -0.08100 | 0.00365 | -2.21733 | 0.0383 |
| $lnPGDP(-1)$ | -0.33726 | 0.25380 | -1.32887 | 0.1989 |
| $lnPGDP(-2) *$ | 0.78918 | 0.30364 | 2.59908 | 0.0172 |
| $lnINV_p(-1) **$ | 0.16549 | 0.08409 | 1.96808 | 0.0631 |
| $lnINV_p(-2)$ | 0.03477 | 0.09152 | 0.37991 | 0.7080 |
| $lnINV_g(-1)$ | 0.10932 | 0.06566 | 1.66482 | 0.1115 |
| $lnINV_g(-2) **$ | 0.11044 | 0.05880 | 1.87832 | 0.0750 |
| $lnPDD(-1) *$ | -0.46127 | 0.20112 | -2.29354 | 0.0328 |
| $lnPDD(-2)$ | 0.25581 | 0.22354 | 1.14430 | 0.2660 |
| $lnPFD(-1)$ | 0.04166 | 0.13342 | 0.31223 | 0.7581 |
| $lnPFD(-2)$ | -0.08142 | 0.11376 | -0.71571 | 0.4824 |
| $lnDSP(-1)$ | 0.11454 | 0.06661 | 1.71977 | 0.1009 |
| $lnDSP(-2)$ | 0.06707 | 0.07406 | 0.90567 | 0.3759 |
| $lnOPN(-1)$ | 0.09816 | 0.15362 | 0.63899 | 0.5301 |
| $lnOPN(-2)$ | 0.04302 | 0.08754 | 0.49146 | 0.6284 |
| $lnPOP(-1)$ | 0.04969 | 0.03174 | 1.56532 | 0.1332 |
| $lnPOP(-2)$ | 0.02146 | 0.02322 | 0.92404 | 0.3665 |
| $Constant$ | 0.06757 | 0.04467 | 1.51286 | 0.1460 |
| R-squared | 0.63646 | Mean dependent var | | 0.1353 |
| S.E. of regression | 0.04627 | S.D. dependent var | | 0.0564 |
| Sum squared resid | 0.04281 | Akaike info criterion | | -3.0034 |

| | | | |
|---|---|---|---|
| Log likelihood | 75.0638 | Schwarz criterion | -2.2277 |
| F-statistic | 2.05966 | Hannan-Quinn criter. | -2.7274 |
| Prob(F-statistic)** | 0.06188 | Durbin-Watson stat | 2.0973 |

Note: * and ** indicate significance at 5% level and 10% level, respectively.

Above short run relationships were further confirmed by estimating Wald tests (Table A3). According to the Wald test, public domestic debt and private investment showed a significant causal relationship to the per capita GDP in the short run, while others indicate no significant association to the per capita GDP. The Wald test also reveals a bidirectional causality between per capita GDP and foreign debt in the short run. This implies that when economic activities in the country improve, the government tends to borrow more foreign debt to enhance the ongoing economic process.

### 5.5 Results of cointegration tests, long run and short run equilibrium relationship of the investment model

### 5.5.1 Cointegration results

The results of the Trace statistics and Maximum Eigen Value statistics of the investment model suggest that there exist four significant long run cointegration equilibrium relationships among the variables (Tables 10 and 11). Similar to the growth model, this indicates that the hypothesis of no cointegration is rejected, suggesting a stable long run association between investment and public debt along with other control variables.

#### Table 10: Johansen cointegration rank test results (trace)

| Cointegration Relations <br><br> Null Hypothesis | Eigen Value | Trace Statistics | Critical Value at 5% level | Probability Value** |
|---|---|---|---|---|
| None * | 0.943981 | 314.6054 | 159.5297 | 0.0000 |
| At most 1* | 0.846392 | 205.0868 | 125.6154 | 0.0000 |
| At most 2* | 0.741980 | 133.8993 | 95.75366 | 0.0000 |
| At most 3* | 0.672621 | 82.41994 | 69.81889 | 0.0035 |
| At most 4 | 0.393962 | 39.98774 | 47.85613 | 0.2230 |
| At most 5 | 0.297767 | 20.95688 | 29.79707 | 0.3603 |
| At most 6 | 0.166715 | 7.524273 | 15.49471 | 0.5176 |
| At most 7 | 0.015507 | 0.593864 | 3.841466 | 0.4409 |

Trace test indicates 4 cointegrating eqn (s) at the 0.05 level. * denotes rejection of the hypothesis at the 0.005 level. ** Mackinnon-Haug-Michelis (1999) p-values.

**Table 11: Johansen cointegration rank test results (maximum eigen value)**

| Cointegration Relations / Null Hypothesis | Eigen Value | Max-Eigen Statistic | Critical Value at 5% level | Probability Value** |
|---|---|---|---|---|
| None * | 0.943981 | 109.5187 | 52.36261 | 0.0000 |
| At most 1* | 0.846392 | 71.18745 | 46.23142 | 0.0000 |
| At most 2* | 0.741980 | 51.47936 | 40.07757 | 0.0017 |
| At most 3* | 0.672621 | 42.43220 | 33.87687 | 0.0038 |
| At most 4 | 0.393962 | 19.03086 | 27.58434 | 0.4122 |
| At most 5 | 0.297767 | 13.43261 | 21.13162 | 0.4132 |
| At most 6 | 0.166715 | 6.930410 | 14.26460 | 0.4974 |
| At most 7 | 0.015507 | 0.593864 | 3.841466 | 0.4409 |

Max-eigenvale test indicates 4 cointegrating eqn (s) at the 0.05 level. * denotes rejection of the hypothesis at the 0.005 level. ** Mackinnon-Haug-Michelis (1999) p-values.

### 5.5.2 Long Run Relationship

As indicated by cointegration results, there exists a stable long run relationship among the variables in the investment model as well. The estimated long run normalised coefficients from the VECM are reported in Table 12.

**Table 12: Cointegration coefficients from VECM**

| Regressor | Coefficient | Standard Error | T Ratio |
|---|---|---|---|
| *lnINV* | 1.000000 | | |
| *lnPGDP* | 0.784885 | (0.08020) | [9.78622] * |
| *lnTPD* | 0.309944 | (0.08673) | [3.57386] * |
| *lnDSP* | -0.085517 | (0.05948) | [ -1.73771] ** |
| *lnDSV* | 0.204336 | (0.04119) | [4.96090] * |
| *lnOPN* | 0.339789 | (0.03963) | [8.57507] * |
| *lnINF* | -0.519546 | (0.06187) | [ -8.39779] * |
| *lnECR* | -0.662331 | (0.11339) | [ -5.84142] * |

* and ** indicate significance levels at 5% and 10 %, respectively.

As per the long run normalised coefficients, there is a clear positive and significant correlation between total public debt and investment in the long run, indicating the indirect effect of public debt on economic growth. Considering the fact that, it can be argued that the investment is one of the basic channels through which public debt can affect economic growth. There is rich empirical evidence, which relates to both Sri Lankan and global contexts to support this conclusion. (eg,. Akram 2017; Munir 2015; Chongo 2013; Hassan 2012). In contrast, debt service payments indicate a long run negative impact on investment, reflecting a marginal crowding out investment as it is significant at 10 per cent level. This implies that high debt servicing cost derived from the increased debt accumulation and high interest rates reduces the investment in the country. This conclusion is also consistent with a Sri Lankan study conducted by Akram (2017). However, it is observed that the overall impact of increasing public debt on investment seems to be favourable as the negative impact of crowding out investment is outweighed by the positive effect of total public debt on investment.

As expected, domestic savings and openness show a long run positive impact on investment with 5 per cent significant level. Openness measures the trade growth and therefore, more openness of an economy causes to increase the investment opportunities (Mhlaba 2017; Riffat 2015). Inflation, which is considered as a direct measure of monetary policy, affects economic growth, and exhibits a statistically significant negative correlation to the investment in the long run. This is supported by the findings of Atique (2012). Exchange rate also shows a significant negative impact on investment in the long run. This result is comparable with the conclusion made by Razzaque (2017). Per capita GDP has a significant impact on investment, suggesting that improving economic activity tends to further invest in the country.

Estimated ECT of the investment model is also significant and indicates a negative sign complying with the VECM conditions. This further confirms that long run relationships prevail among the variables.

### 5.5.3 Results of VECM and Short Run Relationship

The result of the error correction representation is reported in Table 13. Similar to the long run, it is also evidenced from the short run results that debt indicators such as total public debt and debt service payments have a significant influence on investments in the country. The estimates of Wald test also confirm that the short run association remained between the debt ratios and the investments (Table A4). Accordingly, two periods lagged total public debt positively affect investments, reflecting the combined positive effect of both domestic and foreign debt. On the other hand, one period lagged debt service payment shows a negative impact on investments, which is similar to the long run results. These results are consistent with the theories and some empirical evidence previously introduced. Inflation and exchange rate show a negative link to investments in the short run. These outcomes are consistent with the findings made by Mencinger (2014) and Razzaque (2017), respectively. However, openness

indicates a negative correlation with investment in the short run, reflecting an adverse effect of large capital inflow and outflow gap. This is consistent with the findings made by Bibi et al (2012). Per capita GDP positively influences investment even in the short run.

### Table 13: VECM regression results

**Dependent Variable: *lnINV***

|  | Coefficient | Standard Error | T Ratio | Probability |
|---|---|---|---|---|
| *ECT* ∗∗ | -1.63942 | 0.22654 | -7.23674 | 0.0000 |
| *lnINV*(−1) ∗∗ | 1.14331 | 0.18409 | 6.21033 | 0.0000 |
| *lnINV*(−2) ∗∗ | 0.33406 | 0.15242 | 2.19177 | 0.0404 |
| *lnTPD*(−1) | -0.20851 | 0.37332 | -0.55853 | 0.5827 |
| *lnTPD*(−2) ∗∗ | 0.63312 | 0.29672 | 2.13372 | 0.0454 |
| *lnDSP*(−1) ∗∗ | -0.20674 | 0.08262 | 2.50222 | 0.0211 |
| *lnDSP*(−2) | 0.10164 | 0.08503 | 1.19538 | 0.2459 |
| *lnDSV*(−1) | 0.05768 | 0.10449 | 0.55198 | 0.5871 |
| *lnDSV*(−2) | 0.07661 | 0.09672 | 0.79202 | 0.4376 |
| *lnOPN*(−1) ∗∗ | -0.74371 | 0.18032 | -4.12430 | 0.0005 |
| *lnOPN*(−2) | -0.08918 | 0.20329 | -0.43868 | 0.6656 |
| *lnINF*(−1) | -0.19542 | 0.30175 | -0.64762 | 0.5246 |
| *lnINF*(−2) ∗∗ | -0.64860 | 0.18607 | -3.48581 | 0.0023 |
| *lnECR*(−1) | 0.25374 | 0.41838 | 0.60648 | 0.5510 |
| *lnECR*(−2) ∗∗ | -0.77266 | 0.28361 | -2.72437 | 0.0131 |
| *lnPGDP*(−1) | -0.00764 | 0.60617 | -0.01260 | 0.9901 |
| *lnPGDP*(−2) ∗∗ | 2.49624 | 0.49470 | 5.04592 | 0.0001 |
| Constant | -0.24419 | 0.07662 | -3.18677 | 0.0046 |
| R-squared | 0.83051 | Mean dependent var | | 0.0091 |
| S.E. of regression | 0.05801 | S.D. dependent var | | 0.1036 |
| Sum squared resid | 0.06730 | Akaike info criterion | | -2.5509 |
| Log likelihood | 66.4676 | Schwarz criterion | | -1.7752 |
| F-statistic | 5.76479 | Hannan-Quinn criter. | | -2.2749 |
| Prob(F-statistic)* | 0.00016 | Durbin-Watson stat | | 1.9162 |

Note: ** and * indicate significance at 5% level and 10% level, respectively.

**5.6 Post estimation tests**

Major diagnostic tests were carried out to ensure the validity of estimated models. The respective results are tabulated in Table 14. The test for serial correlation (LM test) of both models found insignificant probabilities at 5 per cent level with no serial correlation null hypothesis in the residuals. This implies that the models are appropriate to give valid results. The Heteroscedasticity problem was also addressed by employing the Breusch Pagan-Godfrey technique. The corresponding results indicate that no heteroscedasticity problem in the models due to the failure of rejection of the null hypothesis of no heteroscedasticity at 5 per cent significant level. The normality tests were estimated to determine whether residuals are normally distributed with zero mean or not. The insignificant probabilities of Jarque-Bera test statistics affirm the normal distribution of residuals, suggesting the high validity of the regression models.

**Table 14: Results of diagnostic tests**

| Diagnostic Test | | Growth Model | Investment Model |
|---|---|---|---|
| Breusch-Godfrey serial correlation LM test | | 0.420860 (0.5165) | 0.104052 (0.7470) |
| Breush-Pagan-Godfrey heteroscedasticity | F- statistic | 1.211554 (0.3684) | 0.613530 (0.8548) |
| Jarque-Bera normality test statistic | | 1.032213 (0.5968) | 3.945550 (0.1391) |

Note: Probabilities of the test statistics are given in the Parenthesis.

The robustness of the estimated VECM model was also checked using two standard stability tests: CUSUM and CUSUM following the literature (Pegkas 2018). Accordingly, both CUSUM and CUSUM of Square graphs exhibited that their coefficients lie within the critical boundary with 5 per cent significant levels, reflecting the stability of the coefficients *(Appendix Figures 1 and 2)*.

## 6. Conclusion and policy recommendations

The study investigated the impact of public debt on economic growth and investment in Sri Lanka covering the period from 1977 to 2017. Accordingly, two model specifications namely growth model and investment model were estimated applying Johansen Cointegration and the VECM technique specified under VAR model. The growth model examined the direct effect of public debt on economic growth, while the investment model explored its indirect impact on economic growth.

The long run coefficients of the growth model found that both domestic and foreign public debt have a significant positive effect on economic growth in the long run. This implies that the public debt plays a significant role in generating economic growth of the country. The given argument is supported by similar results found in the investment model, which suggest that public debt has a significant positive effect on investment as well. The results convey that investment is a basic channel through which public debt influences economic growth in the long run. In contrast, debt service payments show a significant long run negative effect on both economic growth and investment, reflecting a crowding out investment in the economy. The VECM that captured the short run dynamics of economic growth also confirmed a short run association between public domestic debt and economic growth. At the same time, the investment model revealed a short run relationship between total public debt and investment. Reflecting a crowding out investment, debt service payments in the investment model also showed a significant negative effect on investment in the short run. Wald test results further confirmed above short run associations relating to both models.

This study mainly facilitates for policymakers to take their investment decisions effectively and efficiently with a prudential debt management in the county. Accordingly, the government should focus its attention on the potential contribution of public debt on economic growth and investments. That is, if Sri Lanka utilises its borrowings for productive investment purposes, it will enhance the investments and thereby economic growth in the country, particularly in the long run.

Parallel to this, it is also required to preserve a prudent debt management strategy in the country when financing government expenditure as higher accumulation of public debt, on the other hand, may have a negative impact on both economic growth and investment to some extent. Improved debt management strategy can reduce the interest cost and other fiscal risks including the rupee depreciation effect, which will offset the adverse impact of crowding out investment to some extent.

Moreover, introducing proactive policy measures is needed to broaden the tax base and thereby enhance the government's revenue targets to finance its budget deficit. This will facilitate the government to fully utilise all borrowed funds for capital development projects. The negative relationship between population growth and economic growth suggests the necessity of improving effectiveness of population growth by reducing its growth and increasing human capital. It is also a responsibility of policy makers to manage public debt closely coordinated with monetary and macroeconomic policies as inflation and exchange rate are negatively correlated to investment.

Future researchers can expand their studies by examining the impact of public debt considering the structural breaks as pre-independence and post-independence. Also, it is important to measure the threshold level of public debt for Sri Lanka. Moreover, future research may investigate the different channels through which public debt impacts economic growth.

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# Appendices

## Table A1: Descriptive statistics of all log variables

| Variable | Mean | Median | Maximum | Minimum | Std. Dev. | Skewness | Kurtosis | Obs.v. |
|----------|------|--------|---------|---------|-----------|----------|----------|--------|
| $lnPGDP$ | 10.75 | 10.78 | 13.33 | 7.87 | 1.62 | -0.02 | 1.88 | 41 |
| $lnINV_p$ | 3.06 | 3.08 | 3.50 | 2.23 | 0.22 | -1.12 | 6.04 | 41 |
| $lnINV_g$ | 1.52 | 1.58 | 2.14 | 1.01 | 0.30 | -0.21 | 1.97 | 41 |
| $lnPDD$ | 3.79 | 3.77 | 4.09 | 3.51 | 0.13 | 0.49 | 2.81 | 41 |
| $lnPFD$ | 3.71 | 3.66 | 4.12 | 3.37 | 0.22 | 0.23 | 1.78 | 41 |
| $lnDSP$ | 2.34 | 2.42 | 2.94 | 1.64 | 0.32 | -0.60 | 2.88 | 41 |
| $lnOPN$ | 4.02 | 4.67 | 4.34 | 3.59 | 0.23 | -0.69 | 2.22 | 41 |
| $lnPOP$ | 0.19 | 0.23 | 0.85 | -1.42 | 0.37 | -2.02 | 10.48 | 41 |
| $lnINV$ | 3.27 | 3.25 | 3.67 | 2.67 | 0.19 | -0.38 | 4.31 | 41 |
| $lnTPD$ | 4.44 | 4.46 | 4.69 | 4.21 | 0.14 | -0.14 | 1.76 | 41 |
| $lnDSV$ | 2.77 | 2.77 | 3.38 | 2.42 | 0.22 | 0.70 | 3.64 | 41 |
| $lnINF$ | 2.86 | 3.03 | 4.78 | 0.06 | 1.37 | -0.29 | 1.98 | 41 |
| $lnECR$ | 4.01 | 4.08 | 5.02 | 2.18 | 0.76 | -0.49 | 2.16 | 41 |

## Table A2: Breakpoint unit root analysis for all log variables

| | Augmented Dickey Fuller (ADF) | |
|---|---|---|
| | Level | First difference |
| $lnPGDP$ | -4.652072 | -6.141737* |
| $lnINV$ | -4.790383 | -7.159949* |
| $lnINV_g$ | -4.515532 | -9.149156* |
| $lnINV_p$ | -4.722472 | -6.123547* |
| $lnPDD$ | -4.186910 | -7.649906* |
| $lnPFD$ | -4.565739 | -8.937415* |
| $lnTPD$ | -3.841406 | -7.928893* |
| $lnDSP$ | -3.804723 | -10.86972* |
| $lnOPN$ | -5.983520* | -9.235561* |
| $lnDSV$ | -4.536860 | -8.646166* |
| $lnPOP$ | -8.993975* | -15.16845* |
| $lnINF$ | -5.449537* | -13.46811* |
| $lnECR$ | -7.296838* | -15.50774* |

| Critical Values | | |
|---|---|---|
| 1% Critical Value | - 5.347598 | - 5.347598 |
| 5% Critical Value | - 4.859812 | - 4.859812 |
| 10% Critical Value | - 4.607324 | - 4.607324 |

* indicates significance at 1%, 5% and 10%.

## Table A3: Results of the Wald Test –growth model

| Variable | *LnPGDP* | *LnINV_g* | *LnINV_p* | *LnPDD* | *LnPFD* | *LnDSP* | *LnOPN* | *LnPOP* | *ECT** |
|---|---|---|---|---|---|---|---|---|---|
| *lnPGDP* | | 4.3782 (0.112) | 4.5854 (0.100)** | 6.0723 (0.048)* | 0.6226 (0.732) | 3.0804 (0.214) | 0.7150 (0.699) | 2.4564 (0.292) | -0.0081 (0.038)* |
| *lnINV_g* | 2.4388 (0.295) | | 0.6046 (0.739) | 4.3324 (0.114) | 4.9668 (0.084)** | 0.3840 (0.825) | 0.1889 (0.909) | 2.0602 (0.357) | -0.0011 (0.931) |
| *lnINV_p* | 7.1323 (0.028)* | 0.0302 (0.985) | | 3.1064 (0.212) | 0.2663 (0.875) | 0.1321 (0.936) | 2.2946 (0.318) | 0.3250 (0.850) | -0.0021 (0.840) |
| *lnPDD* | 0.6836 (0.711) | 0.4265 (0.808) | 0.6364 (0.728) | | 3.0969 (0.212) | 2.4622 (0.292) | 2.8982 (0.234) | 7.7395 (0.021)* | 0.0109 (0.068) |
| *lnPFD* | 8.4702 (0.014)* | 6.7938 (0.034)* | 7.5802 (0.022)* | 7.0053 (0.030)* | | 6.2507 (0.044)* | 6.4352 (0.040)* | 17.1771 (0.000)* | 0.0176 (0.004)* |
| *lnDSP* | 8.4666 (0.014)* | 0.3499 (0.839) | 9.0048 (0.011)* | 1.9749 (0.372) | 5.1048 (0.078)** | | 3.8937 (0.142) | 5.0390 (0.080)** | -0.0182 (0.109) |
| *lnOPN* | 6.9483 (0.031)* | 1.8460 (0.397) | 2.4412 (0.295) | 0.9254 (0.629) | (0.7657) (0.082)** | 4.2272 (0.121) | | 0.2559 (0.879) | 0.0014 (0.808) |
| *lnPOP* | 0.4629 (0.793) | 1.0638 (0.588) | 2.5173 (0.284) | 1.6921 (0.429) | 0.0402 (0.980) | 4.5558 (0.102) | 1.6568 (0.437) | | 0.0010 (0.972) |

Note: probabilities are in the parentheses. * and ** indicate significance at 5% and 10%, respectively.

### Table A4: Results of the Wald Test –investment model

| Variable | *LnINV* | *LnPGDP$_g$* | *LnTPD* | *LnDSP* | *LnDSV* | *LnOPN* | *LnINF* | *LnEXR* | *ECT** |
|---|---|---|---|---|---|---|---|---|---|
| *lnINV* | | 27.4737 (0.000)* | 5.8444 (0.054)** | 6.3752 (0.041)* | 0.7749 (0.679) | 19.499 (0.000)* | 13.397 (0.001)* | 8.3307 (0.016)* | -1.6394 (0.000)* |
| *lnPGDP* | 6.5316 (0.038)* | | 1.8564 (0.395) | 3.5038 (0.173) | 1.3401 (0.512) | 2.3890 (0.302) | 2.6653 (0.264) | 2.7157 (0.257) | -0.1350 (0.509) |
| *lnTPD* | 3.6325 (0.162) | 1.6654 (0.434) | | 2.9297 (0.231) | 0.0115 (0.994) | 2.5318 (0.282) | 1.2444 (0.537) | 3.3017 (0.192) | 0.1828 (0.5464) |
| *lnDSP* | 1.8204 (0.402) | 0.7507 (0.687) | 2.2707 (0.321) | | 2.3219 (0.313) | 0.3608 (0.834) | 2.7414 (0.254) | 1.8129 (0.404) | 0.2619 (0.652) |
| *lnDSV* | 0.6263 (0.731) | 1.1408 (0.565) | 0.0769 (0.962) | 2.1384 (0.343) | | 0.4515 (0.798) | 1.0339 (0.596) | 1.1139 (0.572) | 1.1950 (0.006) |
| *lnOPN* | 8.3094 (0.016)* | 1.2509 (0.535) | 2.2458 (0.325) | 10.189 (0.002)* | 2.5543 (0.279) | | 6.1544 (0.046)* | 0.1957 (0.907) | -0.7042 (0.007)* |
| *lnINF* | 1.3429 (0.511) | 0.0815 (0.960) | 0.4858 (0.784) | 1.5036 (0.471) | 0.5778 (0.749) | 1.5979 (0.449) | | 0.6372 (0.727) | -0.1379 (0.559) |
| *lnEXR* | 1.0972 (0.578) | 0.6554 (0.721) | 0.1196 (0.942) | 1.2289 (0.541) | 0.0557 (0.972) | 9.9179 (0.007)* | 1.8809 (0.394) | | 0.1203 (0.478) |

Note: probabilities are in the parentheses. * and ** indicate significance at 5% and 10%, respectively.

### Figure A1: Results of the stability tests of recursive residuals – growth model
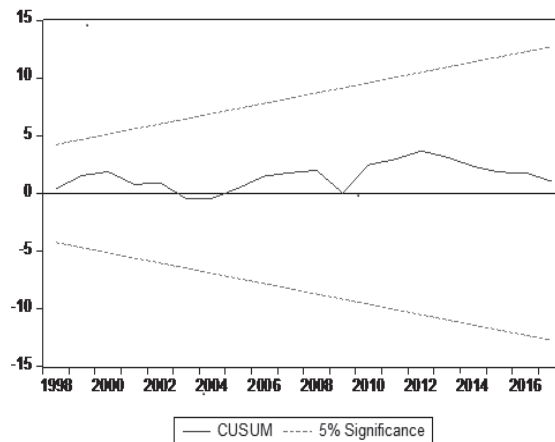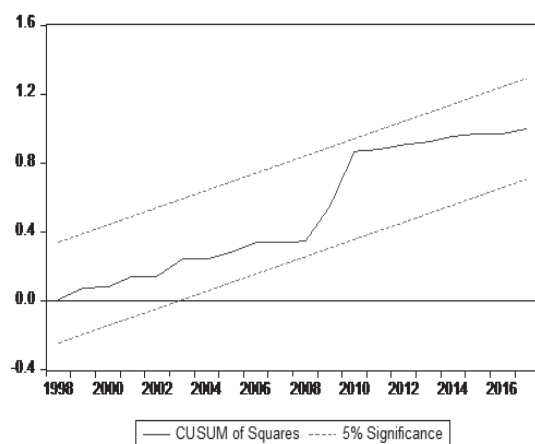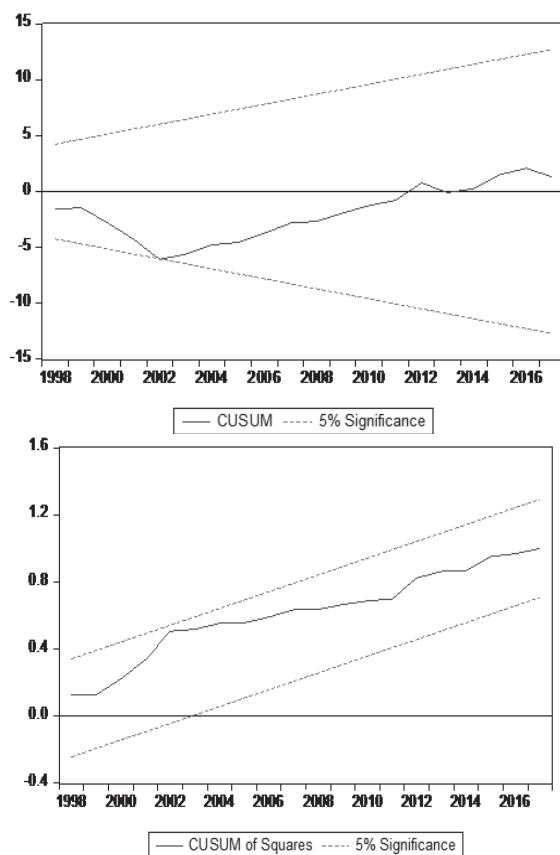
**Figure A2: Results of the stability tests of recursive residuals – investment model**

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**Economic Research Department**
**Central Bank of Sri Lanka**

## For further inquiries, you may contact the following officers:

Dr. Chandranath Amarasekara  - Editor               (chandranath@cbsl.lk)
Mr. Dheeshana Koswatte        - Assistant Editor  (dheeshana@cbsl.lk)
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