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Determinants of Capital Inflows: Evidence from Sri Lanka

Erandi Liyanage[1]

Abstract

This paper investigates the causes of capital flows into Sri Lanka in the form of push and pull factors, using the Fully Modified Ordinary Least Square (FMOLS) approach and the Vector Error Correction Model (VECM) for the period from 2001Q1 to 2015Q2. The study consists of four specifications that employ total capital inflows as a dependent variable and disaggregate the total capital inflows to main three categories. Based on empirical estimates, this study observes that capital flows get attracted largely due to pull factors such as real GDP, interest rate and political stability. The study also establishes that the fundamental causes of capital flows in disaggregate levels differ. These results suggest that Sri Lanka needs to pay close attention to keep domestic macroeconomic variables in the right order in order to attract foreign capitals.

Key Words: *Capital inflows, Pull factors, Push factors, Fully Modified Ordinary Least Square approach, Vector Error Correction Model*

JEL Classification: *C23, F21, F32*

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1. Introduction

Capital flows are one of the key sources of funds for developing countries and are important to sustain economic development. Although inflows[2] of foreign capital can supply the needed capital to support economic development, it can also have an adverse impact on the economy and financial system of the recipient countries if the capital inflows are not properly managed (Yu, 2009). Given the importance of capital flows to an economy, it has received great attention from developing countries in recent decades.

Countries with economic stability and favourable environments for investment attract huge capital flows, augmenting their economic growth and development (Jabbar and Awan, 2014). During the past decade, most of the countries in the South Asian Association for Regional Cooperation (SAARC) region received massive capital inflows due to their rapid economic development and steady export performance (Yu, 2009). In a similar vein, Sri Lanka, which is a small open economy has also attracted capital flows in pursuing its development agenda. With the partial liberalisation of the capital account in Sri Lanka in 2001, the country has benefited from the surge of capital flow. Capital flows into a country can be influenced by many factors. These include economic, social and political developments in both capital exporting as well as importing countries, and could be broadly divided into two major categories; push factors (external factors) and pull factors (internal factors). Push factors are related to the economic cycle and other developments in capital exporting countries, which include changes in world interest rates, changes in the financial systems of capital exporting countries, world growth and the demographic structure of industrialised countries. Pull factors are related to the reforms and future economic growth prospects and other developments, especially in the macroeconomic front in capital importing countries, which include increase in productivity and growth prospects in capital importing countries, domestic financial market reforms, trade and capital market liberalisation and government policies on taxation and foreign investment, flexibility of the labour market and wage structures, as well as domestic interest rates in capital importing countries.

Understanding the determinants of capital inflows is a key concern, since it may have crucial impacts on developing countries like Sri Lanka and its policy implications. Therefore, this paper attempts to investigate the determinants of capital flows into

[2] The balance of payment (BOP), reflecting a country's capital flows and trade, consists of three parts: current account, capital account and financial account. Capital flows are generally captured under the financial accounts of BOP after the revision by the IMF, and represent the amount and direction of capital flows into and out of a country.

Sri Lanka since 2001 in relation to the pull and push factors approach. The key factor to select this time period is that the foreign exchange market liberalised in 2001 by allowing commercial banks to determine the exchange rate (independent float).

This study, however, differs from the existing literature on this subject in the following ways. A probe into determinants of capital flows requires explicit examination of the most relevant set of variables that may relate meaningfully to capital flows. Firstly, this study attempts to examine the determinants of capital flows into Sri Lanka by considering the most important variables such as gross domestic products (GDP) and interest rates, which are commonly known as determinants of capital flows. Existing studies on Sri Lanka do not consider the effects on capital flows via other variables such as private sector credit growth, as well as the effect of the internal conflict which had so long prevailed till 2009. Secondly, previous studies use annual data, but this study employs quarterly data in order to capture the dynamics of variables that could be omitted when using annual time series data. Finally, in addition to analysing total capital flows, a clear distinction was drawn between the three different categories of capital flows, since the literature on capital flows notes that FDI, portfolio investment and other inflows have different drivers.

The remainder of the paper is organised as follows: Section 2 presents a literature review of both the theoretical background and empirical studies. In Section 3, trends and composition of capital flows in to Sri Lanka are discussed including government policies on capital flows. Section 4 describes the methodology, while section 5 presents empirical results. Section 6 discusses the findings, followed by the conclusion and policy recommendations in Section 7.

2. Literature Review

2.1 Determinants of Capital Inflows – Theoretical Background

Capital inflows include foreign direct investment (FDI), portfolio investment and other investment *i.e.,* government long-term loans and private sector long-term loans. FDI occurs when a non-resident acquires a stake of at least 10 per cent in a domestic enterprise, while portfolio investment includes purchases of securities and equity shareholdings (Rummel, 2014). As the most stable form of capital, FDI is generally assumed to be a stabilising factor during episodes of financial crises in emerging market countries. The theory, as well as empirics of the analysis of capital flows, finds that industrial countries are largely benefited from capital flows. Capital flows allow recipient countries to augment domestic savings by tapping into foreign savings, lowering the cost of capital for borrowers, enabling smooth consumption, helping the development of financial markets and institutions and facilitating the transfer of

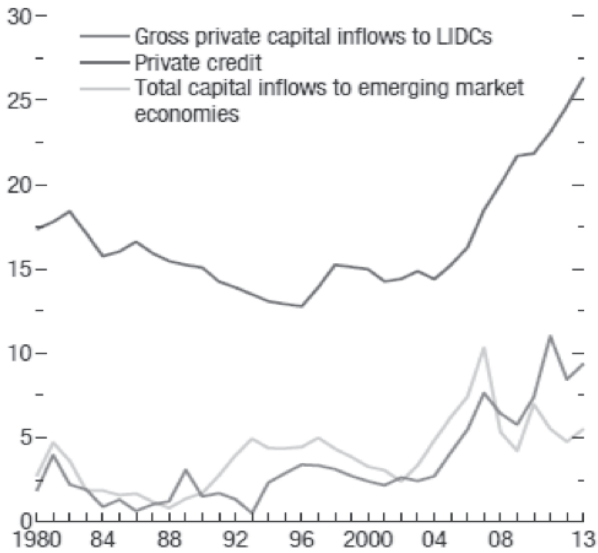
technology and management expertise. At the same time, capital flows allow source countries to improve rates of return available to savers and allow diversification of portfolios (Rummel, 2014).

There are many theories which attempt to explain the determinants of capital flows. According to standard Neoclassical theory, capital flows are driven by return differentials among countries. If there are no restrictions, capital will flow where returns are higher and capital is relatively scarcer, *i.e.,* to developing countries. The second key theory is based on the Capital Asset Pricing Model (CAPM). When securities from different countries show low levels of correlations, investing in foreign assets improves the efficiency of a portfolio, by reducing its overall variance. An implication of the CAPM is that if all investors followed such a strategy, all portfolios in the world should be expected to converge to a standard perfectly diversified world portfolio of international assets (Bonizzi, 2013).

Considering only FDI flows, FDI can take place concurrently in several locations. The reasons for this are explained by the Ownership, Location and Internalisation (OLI) paradigm developed by John Dunning (Mathema, 2004). The paradigm is a blend of three different theories of FDI = O+L+I, each piece focusing on a different question. In the OLI framework, 'O' (ownership advantages) hypothesises that the multinational enterprise has one or more firm specific advantage, which allows it to overcome the costs of operating in a foreign country. The locational advantages 'L' (country specific advantages) explain why certain locations are selected to host the subsidiary operations of multinational companies (MNCs). The selection of investment location depends upon a complex calculation that includes economic, social and political factors. Finally, the 'I' factor means international advantage (Mathema, 2004).

As shown in Figure 1, low-income developing countries have integrated significantly with global financial markets over the past few decades, with annual gross private capital inflows increasing to 6.4 percent of GDP in 2013. Low-income developing countries are typically more credit constrained than advanced economies, and capital inflows can be an important source of financial deepening for these economies to stimulate investment and efficient allocation of resources (IMF, 2015).

Figure 1: Gross Capital Inflows and Private Credit in Selected Low Income Developing Countries (Per cent of GDP)



Source: IMF, October 2015 World Economic Outlook database

Note: Gross private capital inflows and private credit refers to 36 low-income developing countries and total gross capital inflows to emerging markets are based on IMF staff calculations

2.2 Determinants of Capital Inflows – Empirical Evidence

The determinants of capital flows have been broadly analysed in the literature related to the subject. The literature basically examines the determinants of capital flows from developed countries to developing and emerging market economies, in the context of push and pull factors. The low interest rate and volatility in the exchange rate in developed countries, lead to the inflow of capital to developing countries, with stable policies, improved creditworthiness and growing liberalised financial markets (Arshad *et al,* 2012). The relative role of push factors and pull factors vary across different empirical studies. Determining the relative role of push and pull factors in driving capital flows is a crucial issue regarding the actions of the policy makers in capital recipient countries. If capital flows are determined by push factors, domestic policymakers will have little space to control the capital flows. On the other hand, to the extent that capital flows are determined by pull factors, domestic policymakers will have more power on capital flows by introducing sound macroeconomic policies

(Culha, 2006). Further, since different factors cause different types of capital flows, the examination of the disaggregate level would give more insights into formulating policies.

Several studies have examined determinants of capital flows using panel data. In most of the studies, real GDP, current account balance, budget balance, interest rates, labour laws and judiciary system have been used as pull factors. Moreover, many studies which focused on pull factors suggested that stable macroeconomic conditions determine capital flows. In the study carried out by Husain and Jun (1992) on two sub groups, South Asian and ASEAN, reveal that an ample supply of low wage, skilled and educated labour would attract FDI inflows when considering the comparative advantage of South Asian economies. Ralhan (2006) carries a cross-sectional study of eight countries to identify the determinants of capital flows, especially in the wake of economic liberalisation and deregulation, covering the period of 1970–1995. Based on the findings, he suggests that government policies should be directed towards improving the fundamentals of the economy, such as gross foreign reserves, gross domestic product and total external debts in order to attract capital inflows. He finds that gross foreign reserves are one of the most important factors affecting capital flows in all the countries considered, regardless of any region or group. The level of gross domestic product is another factor influencing capital flows and growth in the size of an economy can lead to an increase in capital flows because of growing investors' confidence. The findings of the study of Arshad et al (2012) using the annualised data of six developing Asian countries for the period of 1990–2009 indicate that the dependence on the capital inflow is significant on the reserves, GDP and fiscal policies of the country. Yang *et al,* (2013) examine the determinant of FDI and foreign portfolio investment using the static and dynamic models of six Asian countries and seven Latin American countries. Their results show that expectation factors are in great importance with the FDI and foreign portfolio investment in those two regions and that FDI is highly influenced by the economic expectation, while foreign portfolio investment is dependent upon exchange rate expectation.

In the meantime, several studies find that push factors play a major role in determining capital inflows. Kim (2000) investigates the causes of capital flows in four developing countries; Mexico, Chile, Korea and Malaysia, using structural decomposition analysis and finds that the resurgence in capital movements is largely due to external factors such as decreases in the world interest rate or recession in industrial countries, whereas domestic factors including country specific productivity shocks and demand shocks are relatively less important. Brana and Lahet (2008) investigate the impacts of both external factors and domestic fundamentals on the evolution of capital inflows with a panel of four Asian countries over the period of 1990–2007. Their findings show that both push and pull factors are significant. Push factors such as trade strategies, global

liquidity and contagion factors seem to be major determinants of capital inflows into Asia. However, sovereign ratings, as pull factors, are not the major determinant of capital inflows in Asia during this period.

There are several studies carried out to examine the determinants of capital flows in the context of a single country. Culha (2006) analyses the determinants of capital inflows to Turkey by introducing a Structural Vector Autoregression (SVAR) model with producing impulse response and variance decomposition functions covering the period from 1992:01 to 2005:12. The same analysis has also been carried out for the two sub-periods 1992:01–2001:12 and 2002:01–2005:12 to inspect if there exists a change in the roles of push and pull factors before and after the 2001 economic crisis. The impulse-response analysis in the whole sample period reveals that shocks to foreign interest rates (US interest rate) tend to increase, whereas shocks to domestic real interest rates tend to decrease capital flows to Turkey, which is an inconsistent phenomenon. The analysis over the second sub-period 2002:01–2005:12 points to a 'normalisation' of the economy where the foreign interest rate shocks cause capital outflows and domestic interest rate shocks cause capital inflows, as expected. Impulse response analysis, in general, suggests that shocks to foreign industrial output and exchange index has a positive effect on capital flows into Turkey. There appears to be a negative relation between the shocks to both budget and current account balances and capital flows. Thus Culha concludes that pull factors are dominant over push factors in the determination of capital flows to Turkey during the whole sample period. Similarly, Asraf *et al,* (2010) in their study reveal that pull factors are imperative in explaining the capital flows into Malaysia. Therefore, budget balance and current account balance appear to be the most influential variables that affect inflows of capital into Malaysia.

There is a long-standing impression among policymakers that FDI is more conducive to long-run growth and development than other forms of capital inflows. Hence, several studies have been conducted to examine the determinants of FDI only, rather than capital inflows as a whole. Rehman *et al*, (….) empirically investigate the determinants that are responsible for the insufficient FDI inflow to Pakistan, through testing how important political stability and energy availability are in attracting FDI, beside other determinants during the period of 1980 - 2008. They found that the political instability eroded the investors' confidence in the country and conclude that stability rather than democracy was more important in the choice of the investment decisions.

3. Capital Flows into Sri Lanka

3.1 Trends and Composition of Capital Flows into Sri Lanka

Capital inflows began to play an important role in the Sri Lankan economy after the open economy in 1977. With the open economy, the external sector responded positively to the new incentives. Exports and imports of goods and services expanded, leading to an expanded deficit of the current account, while bilateral and multilateral donors provided large amounts of grants and concessional loans for development work. Meanwhile, foreign private capital inflows increased. Accordingly, the Sri Lankan economy became increasingly integrated with the world economy (CBSL, 1998). Prior to 1977, the trade account largely determined the current account balance. After 1977, private transfers, which largely represent worker remittances from abroad, increased and helped to off-set the impact of enlarged trade deficits on the level of foreign exchange reserves in the country. Meantime, concessional donor assistance was utilised to finance massive infrastructure development projects.

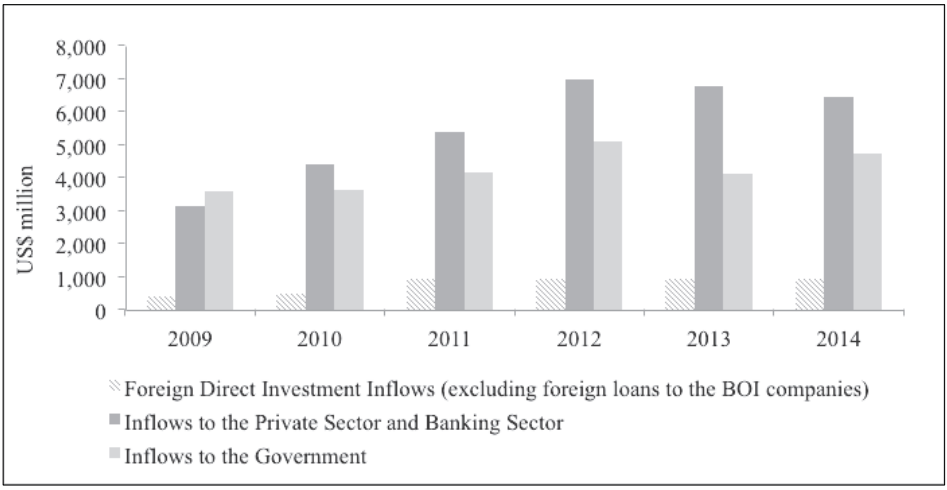
(a) Foreign Direct Investment (FDI)

FDI, which is the principal source of private capital inflows, amounted to US dollars 47 million in 1979 after the initial liberalisation of the economy in 1977. However, this initial momentum could not be maintained due to the loss of Sri Lanka's investment potential as a result of the escalation of ethnic problems into a civil war in 1983. As an example, two electronic manufacturing giants, namely Motorola and the Harris Corporation, which obtained approval from the Board of Investment of Sri Lanka (BOI) to establish plants inside the Katunayake free trade zone in 1982, withdrew their investment projects from Sri Lanka with the uncertainty created by the war (Kelegama 2006). However, with the implementation of the second wave of liberalisation and structural adjustments in 1989, the relative improvement of the macroeconomic environment and other reforms introduced by the government, including the privatisation of state owned enterprises (SOEs), FDI increased gradually (Pushparajah, 2009). As a result, more than two-thirds of the SOEs were acquired by foreign investors in the 1990s (CBSL, 2002).

Before the recovery from the set-back in the late 1990s, the adverse impact of the 9/11 attack in 2001, as well as the attack on Sri Lanka's international airport by the Liberation Tigers of Tamil Eelam (LTTE) caused a drop in FDI flows. However, with the signing of a peace agreement with the LTTE in 2002, a conducive economic environment was visible in the country. Although the LTTE withdrew from negotiations and the government decided to crush the rebels in 2005, FDI flows into the sector have shown a steady growth from 2003. In the year 2011, the country attracted significant inflows of FDI, consequent to achieving sustainable peace after the ending

of humanitarian operations in May 2009. This increasing trend continued thereafter and FDI, excluding borrowings of direct investment enterprises (DIEs) reached US dollars 944 million in 2014, with the improved investor sentiment underpinned by a stable macroeconomic environment. Figure 2 shows the increase in FDI along with other capital inflows after end of the civil war.

Figure 2: Inflows to the Financial Account



Source: Central Bank of Sri Lanka

(b) Portfolio Investment

Notwithstanding the continuing importance of FDI flows, the significance of portfolio flows has also increased in the recent past. Portfolio investment amounted to US dollars 31 million in 1991 with the approval granted for foreign investment in shares of companies incorporated in Sri Lanka. By 1994, private capital portfolio investments increased to US dollars 293 million (2.5% of GDP). The recession and low interest rates in industrialised countries were the main external push factors, whereas high domestic interest rates, further capital account liberalisation and contemporary boom conditions in the Colombo Stock Exchange were some of the important pull factors for this development (Pushparajah, 2009). During 1998–2002, portfolio investments were low due to low profitability of corporate sector, political instability, loss of investor confidence and the heightened security situation. However, it increased again with the improved investor confidence after signing the ceasefire agreement with the LTTE in 2002. With the end of the civil war in 2009, portfolio investments increased considerably. In 2014, inflows in the form of equity and investment fund shares, which

comprise foreign investments other than direct investments in Colombo Stock Exchange (CSE) listed companies, moderated (CBSL, 2014).

(c) Other Investments

Other investment inflows, consisting of private and public sectors' foreign borrowings and suppliers' credits to private sector importers, have been continuously increasing in the post-liberalisation era. The credit extended by foreign suppliers has been growing with the higher import expenditure. The demand for foreign borrowing by the private sector, including public corporations, increased during the 1990s, as there was increased access to foreign funds at relatively low rates of interest rather than the domestic interest rates (Pushparajah, 2009). However, since Sri Lanka graduated to a lower middle income country, the level of capital grants, which is a large part of inflows to the capital account, has declined in the recent past.

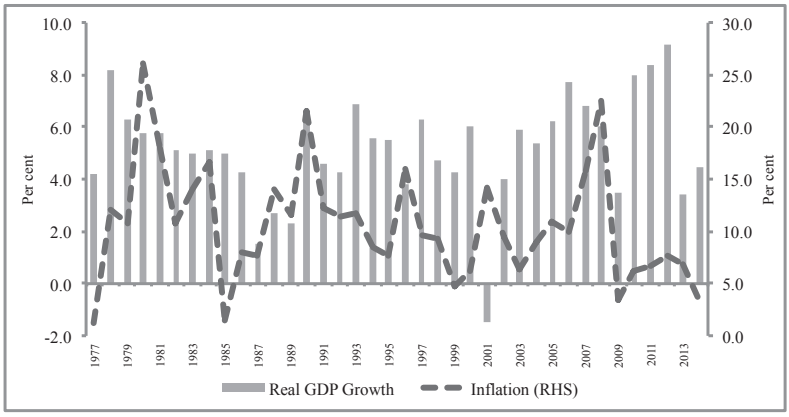
3.2 Macroeconomic Indicators as Drivers of Capital Flows

As high and sustainable economic growth is an indicator of higher long term prospects for investment, it is one of the key drivers of capital inflows. The Sri Lankan economy recorded a 4.2 per cent growth in 1977 and grew by over 5 percent thereafter till 1985. Economic growth has been strong in recent past, specially after the end of the war. The real GDP grew by around 5.7 per cent on average during 2002-2009, after recording a negative growth rate of 1.5 per cent in 2001, the first time since independence. An unfavourable global economic environment, that adversely affected the performance of manufacturing and external trade, the prolonged drought that affected the agricultural output and hydropower generation, coupled with the terrorist attack on the international airport at Katunayake, the subsequent imposition of insurance surcharges on sea and air travel and political uncertainties contributed to this negative growth. Meanwhile, the economy recorded its highest ever growth of 9.1 per cent in 2012. In 2014, the Sri Lankan economy grew by 4.5 per cent.

Inflation, measured based on the Colombo Consumer Price Index (CCPI) increased after the economic liberalisation not only due to the immediate direct effect of the relaxation of price controls, currency devaluation and the removal of subsidies, but also due to continued high budget deficits, which were financed through expansionary sources (CBSL, 1998). Inflation increased to 12.1 per cent in 1978, from 1.2 per cent in 1977 and recorded 26.1 per cent in 1980, the highest level since independence. A fiscal consolidation programme that was initiated since 1995 with the objective of moving the economy to a non-inflationary high growth path caused the containment of inflation at a single digit level by end 1997. The inflation rate increased to a double digit figure in

2001 due to the temporary supply shortage of domestically produced major food items caused by the drought, upward adjustments in administered prices, higher import prices *etc*. With the prudential policy measures and favourable conditions in the international commodity market, Sri Lanka was able to maintain inflation at a single digit level during the last six years since February 2009 and the annual average headline inflation stood at 3.3 per cent by end December 2014.

Figure 3: Real GDP Growth and Inflation



Source: Central Bank of Sri Lanka

The post-independence governments have played a key role in the upliftment of the socio-economic status of the people in Sri Lanka. Despite the economic liberalisation in 1977, the share of the public sector in the economy remained high. Accordingly, Sri Lanka has experienced a high budget deficit for a long period of time and it peaked at 19.2 per cent of GDP in 1980. With the economic reforms in 1977, government involvement in heavy capital expenditure projects, such as the Accelerated Mahaweli Development Programme, power generation and ports development projects had an impact on the increase of capital expenditure, leading to an expansion in the budget deficit. After the completion of these projects, the budget deficit declined to around 7.9 per cent of GDP during the 1990s (CBSL, 1998). The budget deficit narrowed down from 2002, except in the year 2009, reflecting a favourable trend towards the fiscal consolidation and amounted to 6.0 per cent of GDP in 2014.

The current account balance, which represents the external sector fragility, recorded a deficit after the economic reforms in 1977. During the 1978-1985 period, the current account deficit widened to 8.2 per cent of GDP, reflecting the increase of imports due

to the high demand with expanding economic activity, funded large infrastructure development projects and export processing zones (Perera and Liyanage, 2011). However, with the expansion of exports and improvement in both services and transfers accounts, as well as the completion of large donor funded development projects, the current account deficit declined significantly from the high levels of the 1980s and has remained at a single digit level since then. In 2014, the current account deficit declined to 2.7 per cent of GDP with the surplus in the services account and increase in workers' remittances (CBSL, 2014).

The 91 T-bill rate, which is used as the proxy to domestic interest rate in compiling the interest rate differential was 9 per cent in 1977 and was also relatively low volatility particularly during the period of 1989–1996. However, in 1997, the 91 T-bill rate dropped drastically to 9.97 per cent from 17.45 per cent in 1996 and continued to remain low during 2002–2004 and 2009–2014. The same trend has been observed in the 6 month and 1 year T-bill rate.

Table 1: Key Macroeconomic Performance in Sri Lanka (1960 - 2014)

Averages for Decades

Indicator	1960 - 1969	1970 - 1979	1980 - 1989	1990 - 1999	2000 - 2009	2010 - 2014
GDP (US dollars million)	1,658	3,125	5,745	12,230	25,623	67,283
Real GDP Growth (%)	4.7	3.9	4.3	5.2	5.0	6.7
Budget Balance (% of GDP)	-6.0	-7.1	-11.3	-7.9	-8.1	-6.7
Current Account Balance (% of GDP)	-2.8	-2.0	-7.7	-4.8	-3.5	-4.7
Interest Rate - 91 days Treasury bill rate (%)	3.1	6.2	13.6	15.9	12.4	7.8
Exchange Rate (US dollar/Rupee)	5.0	8.6	25.8	52.3	99.7	122.2
Inflation (%)	2.2	6.9	12.8	11.3	10.8	6.1

Sources: Perera and Liyanage (2011)
Central Bank of Sri Lanka

3.3 Government Policies for Capital Flows

With the restrictive and inward oriented policies *i.e.,* the reemergence of a comprehensive system of quantitative restrictions, high tariffs and foreign exchange

controls that were implemented from 1970 to 1977, private capital inflows were at negligible levels. However, with the first phase of Sri Lanka's economic liberalisation under the open economic regime introduced in 1977, capital inflows as a percent of GDP rose to 6 per cent in 1978 from a level of under 1 per cent in the previous year and private capital, both direct investment and loans, turned from a net outflow to a net inflow. With the establishment of the Greater Colombo Economic Commission (later Board of Investment) in 1978 and the first Export Processing Zone, direct inflows grew significantly (CBSL, 1998).

The second phase of economic liberalisation commenced in the early 1990s with the initiation of a mass-scale privatisation programme and the liberalisation of the stock market investments. Subsequently, trade and payment systems were also liberalised and concerted efforts to increase private capital inflows were introduced in 1991. With the approval for foreign nationals to purchase 100 per cent of the issued share capital in the listed companies in 1992, subject to certain exclusions and limitations, Sri Lanka experienced a surge in portfolio investment during 1993 - 1994. Meantime, with the full liberalisation of current transactions in 1993, Sri Lanka accepted obligations under Article VIII of the IMF in 1994, while gradually relaxing the capital account transactions (Amarasekara, 2004). In 1995, commercial banks were permitted to obtain foreign loans up to 15 per cent of their capital and reserves. Further, Sri Lanka abandoned its managed floating exchange rate regime and adopted a full float in 2001 and non-residents were permitted to invest in dollar denominated government securities. Similarly, the country witnessed a surge in capital flows in 2007 and 2008, with the issuance of sovereign bonds in the international markets, higher FDI inflows and increased foreign investment in the Colombo stock market. In 2010, foreign companies were permitted to open places of business in Sri Lanka, while non-residents were permitted to invest in rupee denominated debentures issued by local companies (CBSL, 2010). In 2011, the threshold for foreign investments in Treasury bills and Treasury bonds was increased to 12.5 per cent from 10 per cent of the outstanding Treasury bills and Treasury bond stock, respectively. In 2013, general permission was granted to foreign institutional investors, corporate bodies incorporated outside Sri Lanka and investors resident outside Sri Lanka, to invest in Unit Trusts, subject to certain conditions. Overall, Sri Lanka has taken several progressive measures in order to promote financial openness and enhance a positive investment climate, moving beyond more conventional measures such as offering costly tax concessions, supplying of unskilled labour at low cost etc. Policy focus has shifted towards implementing a proper investment promotion strategy, underpinned by various factors such as political and social stability, improved infrastructure, skilled labour and efficient government institutions (CBSL, 2010).

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However, Sri Lanka having realised the potential disrupting effects of free capital movement, has sought to promote long-term capital inflows rather than short-term flows. Therefore, certain portfolio investment areas in Sri Lanka still remain closed to foreign participation.

4. Methodology

4.1 Model Specification

The determinants of capital flows into Sri Lanka are examined using two different approaches; single equation Fully Modified Ordinary Least Squares (FMOLS) Regression and Vector Error Correction Model (VECM).

The FMOLS approach, proposed by Philip and Hansen (1990), provides optimal estimates of Co-integration regression. The basic idea of the FMOLS approach is to account for the serial correlation and test for the endogenity in the regressors that result from the existence of a co-integrating relationship. Based on the theoretical and empirical concepts, which discussed above, the model for determinants of capital flows is arranged as follows.

$$LNCF = \beta_0 + \beta_1 LNRGDP + \beta_2 BB + \beta_3 CAB + \beta_4 IR + \beta_5 PSC + \beta_6 INIPI + \beta_7 D1 + \varepsilon_t$$

Variables and their expected signs are presented in Table 2.

Table 2: Definition of Variables

	Definition	Expected sign
Push Factors		
AIPI	World GDP (proxied by industrial production index of advanced economies 2010=100)	+/-
Pull Factors		
LNRGDP	Log of Real Gross Domestic Products	+
BB	Budget balance (deficit) defined as the difference between government revenue and government expenditure	+/-
CAB	Current account balance (deficit) is defined as net exports of goods and services plus net factor income	+/-
IR	Interest rate deferential defined as the difference between annualised Sri Lankan month Treasury bill rate and 3 month LIBOR rate	+
PSC	Year-on-year growth of credit granted by licensed banks to private sector	+
D1	Dummy variable to capture the civil war prevailed in Sri Lanka	-

It is observed that the RGDP has a positive relation with CF, as an economically thriving country can attract more inflows of capital. In contrast, the BB and CAB are anticipated to have either positive or negative relationships with CF depending on how the variables are perceived. If the variables are looked at, as fiscal and external fragilities to a country, respectively, these two variables might have a negative relationship with capital inflows. This is because large budget and current account deficits denote unfavorable domestic economic conditions, thus making a country less attractive to capital inflows from abroad. However, if we consider the variables from a direct angle, they might have a positive nexus with capital inflows, as widening deficits in current account and budget balances imply a substantial demand for capital inflows from other countries to finance the deficits (Abdullah, 2010). The IR is expected to have a positive relationship since higher domestic interest rate attracts foreign capital. The PSC is expected to have a positive relationship with CF since the development of the financial sector, represented by PSC, would attract more capital flows. The strength of the advanced countries' economy, which is proxied by AIPI, may have two implications on capital flows into emerging/developing economies. On one hand, an improvement in the industrial production index shows the ability of advanced countries in accumulating capital to fund economic activities in developing countries. On the other hand, it leads to inflationary pressure in advanced economies, hence raises its interest rates. Higher interest rates in advanced economies attract inflows of capital into advanced countries, thereby reducing the amount of capital flows to emerging/developing economies (Puah, 2010). D1 is expected to have a negative relationship since political instability causes less attraction in capital inflows.

This study consists of 4 specifications. Specification 1, the main model, employs total capital flows as a dependent variable. The dependent variable in specification 2, 3 and 4 is FDI, portfolio investment and other capital inflows, respectively.

4.2 Data Description

This study uses quarterly data which span from 2001Q1 to 2015Q2. Data are obtained from various issues of Annual Reports of the Central Bank of Sri Lanka (CBSL) and the International Financial Statistics (IFS) published by the International Monetary Fund (IMF). The reason for employing data from 2001 is that it was the year that Sri Lanka liberalised the foreign exchange market by allowing the commercial banks to determine the exchange rate. Inflows data for the year 2012Q1 to 2015Q2 have been compiled based on the Balance of Payments Manual 6 (BPM6), while data for the balanced period have been compiled based on the BPM5.

The dependent variable in this study is the capital inflows (CF), which is obtained by summing up FDI, portfolio investment, government long-term loans and private sector

long-term loans. The rational to form aggregated data from these four flows is that they are major components of capital flows in the financial account of a country. The independent variables used in this study include both the pull and push factors that affect capital flows into a country. For the pull factors, RGDP is applied because it neutralises the effect of inflation and represents the domestic performance of an economy and is widely cited in many literatures on the determinant of capital inflows into a country (Abdullah *et al*, 2010). BB, which is obtained by deducting total government expenditure from total government revenue, denotes the fiscal fragility of a country. The CAB indicates the external sector fragility. IR refers to the interest rate differential, which is the difference between the annualised Sri Lankan 91-Tbill rate and 3 month US LIBOR. The PSC represents the financial development of the country. Further, global financial crisis during 2007–2009 and internal conflict until 2009 were included the sample period. The effect of the internal conflict of the country on capital inflows is captured in dummy variable 1 (D1)[3]. The push factor examined in this study is the industrial production index of advanced economies (AIPI), which is used as the proxy for advanced countries' economic performance. Variables CF and RGDP are in natural logarithm form and all variables are seasonally adjusted to remove seasonal effects.

4.2.1 Descriptive Statistics

The descriptive statistics of the final data series used in the analysis after required transformations for the full sample are given in Table 3.

Table 3: Descriptive Statistics with Transformed Data

	LNCF	LNRGDP	BB	CAB	IR	PSC	AIPI
Mean	6.28	7.09	-724.29	-408.24	2.37	15.90	102.02
Median	6.31	6.84	-603.53	-309.84	2.13	15.17	101.86
Maximum	7.72	9.22	-229.31	148.82	4.42	35.13	111.29
Minimum	4.79	5.45	-1,777.74	-1,547.84	1.11	-5.92	90.71
Std. Dev.	0.68	0.97	393.11	435.59	0.86	10.38	4.63
Observations	58	58	58	58	58	58	58

Table 3 shows that, on average, the budget deficit amounted to US dollars 724 million per quarter, while the current account deficit amounted to US dollars 408 million.

3 Since AIPI reflects the impact of global financial crises on advanced economies, it is not included as an explanatory variable.

The interest rate differential has been, on average, around 2.4 per cent. The credit granted to the private sector by licensed banks has increased on average, by 15.9 per cent, year-on-year, while the AIPI was around 102.0 index points. All variables show considerable volatility.

4.2.2 Stationarity Properties of Data

In this study, the Augmented Dickey-Fuller (ADF) unit root test and Phillips-Perron (PP) test are utilised to examine the stationarity properties of the data used in the model. The optimal lag length is selected based on Schwarz Information Criterion (SIC). These unit root tests are performed on both level and first differences. Summary results of the ADF test and PP test are given in Table 4.

Table 4: Results of Unit Root Tests

Variable	Indicator	ADF Test		PP Test	
		Level	1st difference	Level	1st difference
LNCF	t-Statistic	1.1940	-11.7620	0.6705	-12.3871
	P-Value	0.9386	0.0000	0.8579	0.0000
LNRGDP	t-Statistic	0.6197	-9.3515	1.1655	-9.5215
	P-Value	0.8474	0.0000	0.9355	0.0000
BB	t-Statistic	1.6254	-10.7001	-1.4091	-27.6904
	P-Value	0.9733	0.0000	0.1462	0.0000
CAB	t-Statistic	-1.5375	-4.7787	-1.4818	-3.5878
	P-Value	0.1155	0.0000	0.1282	0.0006
IR	t-Statistic	-2.4450	-4.7014	-0.8478	-4.7442
	P-Value	0.1345	0.0003	0.3443	0.0000
PSC	t-Statistic	-0.3139	-4.8868	-1.2055	-3.2957
	P-Value	0.5674	0.0000	0.2063	0.0014
AIPI	t-Statistic	0.2086	-3.9409	0.1290	-3.8973
	P-Value	0.7432	0.0002	0.7194	0.0002
LNFDI	t-Statistic	0.9389	-8.3652	1.0527	-8.3529
	P-Value	0.9055	0.0000	0.9217	0.0000
LNPFI	t-Statistic	0.2913	0.7667	0.4288	-11.3526
	P-Value	0.7667	0.0000	0.8031	0.0000
LNOCF	t-Statistic	0.6422	-8.6864	0.1779	-12.1240
	P-Value	0.8520	0.0000	0.7342	0.0000

Source: Author's Calculations

At levels, all the variables failed to reject the null hypothesis of 'the series has a unit root' at a 5% significant level. Accordingly, all the variables are non-stationary at levels and stationary after the first differencing, hence they are said to be I(1) variables.

5. Empirical Results

Following the unit root test results shown in Table 4, which indicate that the time series variables are integrated of order one I(1), the next step is to examine whether or not there is at least one linear combination of the variables that is integrated of order zero, I(0), and hence, if there exists a stable and non-spurious cointegrated relationship in the long run between time series variables (Miguel, 2000). Accordingly, the co-integration test is performed.

5.1 Co-integration Test Results

The Johansen approach can determine the number of cointegrated vectors for any given number of non-stationary variables of the same order. The results of trace statistics and Johansen's maximum likelihood test, based on maximum eigenvalue of stochastic matrix are shown in Table 5.

Table 5: Co-integration Test Based on Trace Statistic

Specification	Trace Test r = 0	Maximum Eigen Value Test
Specification 1	153.40***	50.21***
Specification 2	158.84***	50.05***
Specification 3	162.52***	56.03***
Specification 4	153.98***	49.06***

Note: Specification 1, 2, 3 and 4 represent total capital inflows, FDI, portfolio investment and other capital inflows, respectively, as the dependent variable.

Co-integration test confirms the existence of a long-run equilibrium relationship between the variables.

5.2 Long-run FMOLS Results

Since the model variables are co-integrated, the long-run FMOLS estimate developed by Philip and Hansen (1990) can be used to identify and estimate the impact of variables that exert influence on capital inflows. The FMOLS technique has an edge over the Ordinary Least Square (OLS) technique that it is able to take into account both the serial correlation and endogeneity problems present in the variables.

Table 6: Results of Fully Modified Ordinary Least Squares Regression

Independent Variable	Dependent Variable			
	Total Capital Inflows	Foreign Direct Investment	Portfolio Investment	Other Investment
Log Real GDP	0.1584	0.3799	0.3581	0.0760
	[1.9840]*	[5.3557]***	[2.0098]***	[0.8419]
Budget Balance	-0.0005	-0.0002	-0.0006	-0.0005
	[-3.2184]***	[-1.7433]*	[-1.8664]*	[-2.9222]***
Current Account Balance	-0.0001	-0.0003	-0.0001	-4.94E-05
	[0.9094]	[-2.3314]**	[-0.3416]	[-0.3074]
Interest Rate Differential	0.1327	0.1844	0.0445	1.1461
	[2.3042]**	[3.6031]***	[0.3464]	[2.2431]**
Private Sector Credit Growth	0.0076	0.0091	-0.0056	0.0127
	[1.4104]	[1.9096]***	[-0.4639]	[2.0912]**
Industrial Production Index of Advanced Economies	0.0399	0.0618	0.1092	0.0136
	[3.8679]***	[6.7299]***	[4.7369]***	[1.1564]
Dummy Variable for Civil War	-0.4566	-0.0821	-0.2945	-0.5927
	[-2.8932]***	[-6.2851]**	[-4.8360]**	[-3.3193]***
Constant	0.5177	-5.142	-9.798	3.3203
	[0.4467]	[-4.9934]***	[-3.7879]***	[2.5325]**
No. of Observations	58	58	58	58
R-squared	0.7802	0.8017	0.5882	0.6837

t-statistics are in square brackets
* Significant at 10% ** Significant at 5% *** Significant at 1%

According to the FMOLS results, unlike push factors, pull factors have a different impact on different types of capital flows. For instance, Table 6 shows that some of these factors exhibit a high degree of association with FDI, whereas portfolio investment and other investment flows are weakly correlated with them. The GDP has a positive and significant impact on attracting all type of capital inflows. The results

suggest that a 1 per cent increase in the GDP will increase the total capital inflows by 0.16 per cent. The 0.38 per cent of coefficient of real GDP, in relation to FDI, reflects that the real GDP is a main factor that attracts FDI. This result emphasises the important role that economic growth plays in attracting capital flows into Sri Lanka. BB has a negative relationship with capital inflows as expected and is significant. This relationship can be found with all different types of inflows including total inflows. The CAB is insignificant with all categories except FDI. The IR has a positive relationship with CFs and significant with total capital flows, FDI and other investment. Growth of credit to the private sector is significant only with FDI and other investment. As shown by the findings, the civil war has a negative impact on capital inflows, both in aggregate level and disaggregate levels. This clearly shows that political stability is very important to attract capital flows. In terms of push factors, the world industrial production index is positively associated with all types of capital inflows and is statistically significant at 1% level, except other investments.

The model is estimated under two alternative scenarios, *i.e.,* model 1 and model 2 to check the robustness of the results. The results of alternative models are given in Appendix II. As an alternative to real GDP, industrial production index was used in the model 1 and government revenue was used for budget balance in the model 2. Accordingly, is it found that economic performance and fiscal fragility of the country have a positive impact on capital inflows. Moreover, interest rate differential and industrial production index in advanced countries have a positive relationship with capital inflows in both alternative scenarios, whereas internal conflict has a negative relation.

5.3 Vector Error Correction Model

Next, considering the possible endogeneity among selected variables, this paper also uses the Vector Error Correction Model (VECM) to identify determinants of capital inflows. Table 7 shows the results of the VECM.

Table 7: Normalised Co-integrating Coefficients

		Pull Factors					Push Factors
	LNCF	**LNRGDP**	**BB**	**CAB**	**IR**	**PSC**	**AIPI**
β Coefficient	1	-1.311	0.005	-0.004	-1.459	-0.178	-0.004
Standard Error		0.187	0.001	0.000	0.147	0.012	0.021
T-Statistics		-6.999**	6.753**	-11.826**	-9.954**	-14.417**	-0.166

***Significant at 5% level*

Accordingly, the t-statistics confirm that LNRGDP, BB, CAB, IR and PSC are significant at a 5% level. As per the results, the expected signs of all variables hold true. The coefficient of Error Correction Term of D(LNCF) is -0.328. This indicates that 32.8 per cent of the deviation from the equilibrium is corrected within a quarter, taking around 3 quarters to reach long run equilibrium.

Accordingly, the determinants of capital flows into Sri Lanka can be specified as follows:

$$LNCF = -13.05 + 1.31\ LNRGDP - 0.005\ BB + 0.004\ CAB + 1.46\ IR + 0.18\ PSC + 0.004\ INIPI - 2.36\ D1$$

As per the estimated equation above, a 1 per cent increase in the real GDP would increase the capital flows into Sri Lanka by 1.31 per cent, while an increase in budget deficit by 1 per cent, would decrease the capital inflows by 0.005 units. Capital inflows increase by 0.004 units when current account increases by 1 per cent, while a 1 per cent increase in the interest rate differential will lead to increase capital inflows by 1.46 per cent and 1 per cent increase in credit granted to the private sector will lead to increase capital inflows by 0.18. Moreover, the internal conflict had a negative effect of 2.36 per cent on capital flows in to Sri Lanka.

6. Discussions of Findings

Findings of the study using FMOLS confirm that the variables, real GDP, interest rate differential and world GDP have a positive effect on the total capital inflows, while the budget deficit has a negative effect as expected. However, the current account balance and private sector credit growth are not significant. The results of the VECM confirm that real GDP, current account deficit, interest rate differential, private sector credit growth and world GDP have positive effects on the total capital inflows, while the budget deficit has a negative effect. All the variables, other than world GDP are significant.

Based on both techniques, an increase in the GDP is found to attract more capital flows to Sri Lanka in the long run. This is consistent with the findings of Ralhan (2006), Pushparajah (2009) and Puah *et al* (2010). Economic growth can lead to an increase in capital flows because of growing investors' confidence. Further, according to Fernandez-Arias and Montiel (1996), the growth in resources increases country creditworthiness, and the increase in creditworthiness attracts more capital flows. According to the results of FMOLS and VECM, the budget deficit has a negative sign as expected. This is consistent with the studies of Hernandez and Rudolf (1994), Dasgupta and Ratha (2000), Hernandrz *et al*. (2001), Kara (2007) and Abdulla *et al.*

(2010), who suggest that the budget balance is imperative in explaining capital inflows. Based on the VECM, the current account deficit has a positive relationship with capital inflows. This result is not consistent with Culha (2006) who finds that the current account deficit and capital inflows have a negative relation, suggesting that the current account balance is perceived as an external fragility indicator. However, the widening current account deficit requires essentially foreign financing in terms of portfolio investments and/or foreign direct investments, leading to a rise in capital inflows. Further, the FMOLS results show that the current account balance is significant with the FDI. Based on FMOLS and VECM, IR, the interest rate differential, which is the proxy of the real return to capital exporting countries, has a positive relationship with capital inflows since higher returns encourage higher inflows. This is consistent with the findings of Celasun *et al*. (1999), which show that the short-run interest rate differential appears to be the most important pull factor in determining capital inflows to Turkey.

In terms of push factors, based on FMOLS results, the AIPI has a positive effect on capital inflows, in accordance with previous empirical evidence. For instance, Kim's (2000) study on four developing countries; Mexico, Chile, Korea and Malaysia finds that resurgence in capital movements is largely due to push factors such as recession in industrial countries or a decrease in the world interest rate.

Based on the FMOLS, when considering the capital inflows in disaggregates levels, the interest rate differential has a positive relationship only with FDI and other investments. With the increase in the interest rate differential, the domestic cost of financing increases for Direct Investment Enterprises, therefore, investors look more to equity financing other than debt financing, creating more attractive prospects for FDI to a country. The interesting point is that the CAB is significant only with FDI. Basically the rules and regulations pertaining to entry and operations of foreign investors, trade policy, privatisation policy and business facilitation measures are the main requirements to attract investment in the form of FDI. The BOI provides attractive incentives to foreign investors such as long tax holidays, tax exemption and duty free imports of investment goods as well as infrastructure development facilities, which were not captured in this model, nevertheless may also be important in attracting FDI.

The determinants of PFI are somewhat more complex because portfolio investment earnings are more likely to be tied to the broader macroeconomic indicators of a country. Like other factors, real GDP and AIPI have positive relations with PFI and are significant at a 1% level. This is consistent with the finding of Chukwuemeka (2008), which shows that PFI flows into Nigeria has a positive long run relationship with the growth of real non-oil GDP. However, other capital inflows i.e. government and private

sector long term loans are significant only with the budget deficit, interest rate differential, credit to private sector and civil war.

7. Conclusion and Policy Recommendations

As in many developing countries, foreign capital flows are found to be one of the key sources of funds for Sri Lanka and are important to sustain economic development. Understanding the determinants of capital inflows is a key concern, because it may have a crucial impact on developing countries like Sri Lanka and its policy implications.

This study investigates the determinants of capital flows to Sri Lanka in 2001:1-2015:2, using the FMOLS approach and the VECM. As pull factors, real GDP, budget balance, current account balance, interest rate differential, credit to private sector and a dummy variable to capture the impact of the internal conflict prevailed in Sri Lanka, have been investigated, while industrial production index of advanced economies is used as a push factor. Further, since different factors cause different types of capital flows, the disaggregate level of capital inflows were examined to give more insights into formulating policies.

According to empirical findings, the FMOLS confirms that total capital flows into Sri Lanka are determined by real GDP, budget balance, interest rate differential, civil war and world GDP. Current account balance and credit to private sector are insignificant, in contrast to the many empirical evidences. However, in the disaggregate level, the current account deficit is positively correlated with FDI and credit to the private sector positively correlated with FDI and other investment. Based on the VECM, all considered variables, except budget deficit, have a positive effect on the total capital inflows as predicted. However, the coefficient of the industrial production index of advanced countries is not significant.

The findings suggest that pull factors have a dominant role in determining capital flows into Sri Lanka. The policy makers of a country cannot control the capital inflow in the form of FDI directly, but on the other hand they can control the macroeconomy that directly affects the inflows. Therefore, as a small open economy, it is vital for Sri Lanka to keep the domestic macroeconomic variables in the right order to attract more foreign capital. Furthermore, sustained growth and inflows can be achieved by controlling the GDP, and fiscal policies and by making and implementing fruitful policies. At the same time, different policy measures should be taken to attract different categories of capital inflows.

Future studies can focus on the qualitative variables relating to regional competency and political stability, which may be more important in determining capital flows. Such variables should include judicial system, labour laws and the prevalence of corruption facilities.

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Appendix I: Summary of the Empirical Evidence

Authors	Scope	Methodology	Key Findings
Abdullah M A, Mansor S A and Puah C H (2010)	Quarterly data of Malaysia from 1985Q1 to 2006Q4 for the following variables - Real GDP - 3-month T-bill rate - budget balance - current account balance - US industrial production index - world interest rate	Johansen and Juselius technique to test long run relationship Error Correction Model to detect the long run divergence from the equilibrium relationship between the explanatory variables and capital inflows	BB and CAB appear to be the most influential variables in affecting the inflows of capital into Malaysia and GDP and Industrial countries' out put
Arshad, Majeed & Shah (2012)	Annual data of six developing economies of Asia from 1990 to 2009 for the following variables - foreign reserves - current account - fiscal position - GDP - public debt	Hausman specification test and fixed effects model are used to analyse the panel data	Empirical results show that foreign reserves and GDP positively influence the capital inflow, while the current account has a negative relation in developing countries
Culha A A (2006)	Monthly data of Turkey from 1992:01 to 2005:12 for the following variables - 3-month US Treasury bill - US industrial production index - Turkish real Treasury bill rate - Istanbul stock exchange price index - budget balance - current account balance	Structural VAR to identify the main determinants of capital inflows. Impluse Response Function and Variance Decomposition Function are also performed	Empirical evidence suggests that the relative roles of some of the factors have changed considerably in the post crisis period and pull factors are general dominant over push factors in determining capital flows into Turkey
Hernandez, Mellado & Valdes (2001)	Annual data of developing countries from 1977 to 1997 for the following variables	Panel data analysis was used	Results show that private capital flows are determined mainly by a country's own

	- US dollar 3-month - LIBOR minus US CPI - Net private capital flows available to all developing countries minus flows received by country - GDP in industrial countries - real GDP growth - budget balance - Gross domestic investment - total exports - foreign debt - private sector credit - real exchange rate		characteristic and external factors are not significant in explaining the inflows
Kara (2007)	Monthly data of Turkey from 1992:1 to 2006:4 for the following variables - Turkish ex-post real interest rate - real effective exchange rate - real income growth - budget balance - total central government debt to international reserves - United States real interest rate - real income growth - real interest rate	Johansen cointegration analysis is employed for empirical investigation	Results show that capital flows increase in response to increases in Turkish real interest rate, real effective exchange rate, real GDP growth, budget balance to GDP ratio, and decreases in total central government debt to international reserves ratio and the US real interest rates.
Kim Y (2000)	Annual data of Mexico, Chile, Korea, and Malaysia for the following variables - terms of trade - foreign output - foreign interest rate - domestic potential output	SVAR model to investigate the sources of capital flows	The results reveal that the resurgence in capital movements is largely due to external factors such as decrease in the world interest rate or recession in industrial countries, whereas domestic factors including country specific

	- domestic non-monetary aggregate demand - inflation - domestic money		productivity shocks and demand shocks are relatively less important.
Pushparajah P (2007)	Annual data of Sri Lanka from 1977 to 2007 for the following variables - world real GDP growth rate - world real interest rate (proxied by 1-Year US $ LIBOR rate) - real GDP growth - interest rate for fixed deposit - budget balance - current account balance - stock price - exchange rate	OLS-based autoregressive distributed lag (ARDL) model is adopted for cointegration analysis	The long-run results show that real GDP and real interest rates are positively associated with capital inflows, while world real GDP is negatively associated with capital flows.
Ralhan (2006)	Annual data for the following variables - London Inter-bank Offered Rate - rate of inflation - total external debt - GDP - gross fiscal deficit - gross foreign exchange reserves - degree of openness of the economy	Conventional approach and Non-linear Seemingly Unrelated Regression estimation are used	Results reveal that gross foreign reserves are one of the most important factors affecting capital flows in all of the countries considered, regardless of any region or group. The level of gross domestic product is another factor influencing capital flows and growth in the size of an economy can lead to an increase in capital flows because of growing investors' confidence.

Appendix II: Robustness Check (Alternative models)

In order to check the robustness of the results the following alternative models were analysed.

Variable	Model 1	Model 2
Constant	-12.247 -2.638	0.928288 [0.5887]
Log Real GDP		0.20102 [1.9091]*
Industrial Production Index	0.0042 [2.3314]**	
Budget Balance	-0.000519 [-3.3015]***	
Government Revenue		2.67E-07 [1.9879]**
Current Account Balance	-0.0002 -1.0763	-0.0002 -1.3551
Interest Rate Differential	0.0942 [-2.1091]**	0.1614 [2.2956]**
Credit to Private Sector	0.0043 [0.8504]	0.007745 [1.3622]
Industrial Production Index of Advanced Economies	0.03536 [2.9839]***	0.03482 [2.5301]**
Dummy variable for Civil War	-0.48926 [-2.3286]**	-0.5255 [-2.2205]**
Number of Observations	58	58
R-squared	0.762	0.755

t-statistics are in square brackets

* Significant at 10% ** Significant at 5% *** Significant at 1%

Tax Composition and Output Growth: Evidence from Sri Lanka

Mayandy Kesavarajah[1]

Abstract

The role of taxation in determining output growth has been at the centre stage of debate amongst economists, policy makers and researchers over the period. One of the major areas that was more vigorously debated in the field of public finance is whether the changes in tax composition are matters for output growth in the long term. On the empirical front, less conclusive results have been highlighted in the literature. The purpose of this study is to estimate the effects of revenue-neutral tax structure changes on long term economic growth in Sri Lanka within the framework of an endogenous growth model using time series annual data over the period 1980 to 2013. The empirical results of this study indicated while there is an unidirectional causality which is running from income taxes, value added tax and international taxes to output growth, the excise taxes and other taxes are caused by output growth. The study also found negative and statistically significant impacts of income taxes and other taxes on growth. This reflects, apart from income taxes, other taxes which are taxes on other economic activities has hindered the long term growth. Hence, the only robust result appears to be that shifts in tax revenue towards consumption taxes are associated with faster growth.

Key Words: *Fiscal policy, Tax structure, Growth*

JEL Classification: *E62, H21, O47*

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1. Introduction

Do countries with lower tax barriers experience faster economic growth? Few questions have been more vigorously debated in the history of economic literature. It is critical to ask how well the evidence supports the presumption that having lower tax rates would promote growth. Some policy makers argue that increasing taxation is vital to reduce long term debt level and attain macroeconomic stability. Conversely, some policy makers debate that a lower level of taxation promotes both saving and investment and thereby stimulates growth. Along with this, some argue that taxation can be used to attain economic objectives such as fair distribution of income and wealth, efficient resource allocation and economic stabilisation (Musgrave, 1989). However, in the short term, despite the changes in overall level of taxation have an unambiguous impact on aggregate demand, their long term impact on output growth has resulted in much more debate and varied conclusions in the economic literature. In this respect, the role of taxation in determining output growth has emerged as a central question among economists, policy makers and researchers over the periods and emerged as a special policy relevance in the area of public finance. The recent global economic crisis also further intensified on reforming tax structure policies to be in line with "growth promoting" while maintaining fiscal stability in most of the economies. Nevertheless, the outcome of possible impact of taxation on growth would largely depend on the net effect of individual tax components.

Government is an economic agent which collects money through taxation and spends on education, subsidies, infrastructure, government consumption, *etc*. However, despite the financing of all these government expenditures can be growth retarding, in general, the provision of social and physical infrastructure through government expenditure can improve productivity through a more skilled workforce and efficient allocation of resources. Therefore, issues relating to criteria for the allocation of government expenditure among different sectors and implementing appropriate tax policies are of special policy relevance which are directly related to the country's and development. In the wake of this, understanding the channels through which public finance instruments, such as tax policy, expenditure policy, and overall budgetary policy could affect long term output growth would help policy makers to ascertain how to redirect public expenditure and revenue, and to give more attention to the components of the tax revenue which promote growth. In particular, to which sector the government should allocate its expenditure and on in which activities the government should impose taxes with the objective of stimulating growth while maintaining macroeconomic stability (Afonso and Furceri, 2008).

In practice, many developing countries appear to face severe budgeting pressures with rising demand for expenditures given the limited scope for raising extra government

revenue. Specifically, the revenue system that are placed in many developing countries themselves generate strong impediments to efficiency, expansion of the economy, growth of tax base, equity and the achievement of development objectives. Hence, tax reform should be at central to public policy and development planning which has been placed by many governments in practice in the recent period.

The objective of this paper is to explore whether there is any revenue-neutral tax structure adjustment that could be associated with faster output growth in the long term in Sri Lanka. In case of Sri Lanka, less conclusive results have been set out in the empirical literature upon the possible impact of taxation on output growth. In this respect, the present study tries to fill the existing gap in the current empirical literature through examining the possible impact of disaggregate tax revenue on the output growth and thereby tries to shed some light on these arguments empirically via analysing comprehensive data[2] set within the framework of an endogenous growth model. More specifically, the study estimates how changes in the tax structure have affected the long term output growth in Sri Lanka.

The rest of the paper is structured as follows. While section two discusses the theoretical and empirical studies of taxation and growth, section three discusses the data, model, and methodology adopted in this study. Then given the focus of this study, section four is devoted to analyse the trend and composition of tax revenue in Sri Lanka. Section five brings out the empirical evidence on the growth effects of taxation from a time series perspective which would provide more quantitative insights to the policy makers. The final section summarises the major findings and provide policy recommendations.

2. Literature Review

2.1 Theoretical Framework

Identifying critical factors that determine output growth is important to advocate appropriate policy reforms and to assess their impact on growth and development. Over the decades, a number of growth theories have emerged proposing the determinants of growth within a country and the reasons for differences across countries over the period in the literature (Dornsbush and Fisher, 1990). The most prominent models are the Harrod-Domar growth model, the exogenous growth model of Solow and Swan (1956) and the endogenous growth model. On the theoretical front, while classical economists focused merely on the capacity side (supply side), the early Keynesian economists only studied the problem of demand side. The Harrod-Domar growth theory extended the

[2] Appendix table 3 depicts the result of descriptive statistics of the variables used in this study.

Keynesian short term analysis and considered both demand as well as capacity effects of investment. In particular, the model explained the growth rate in terms of the level of saving and the productivity of capital and thereby sought to determine the unique rate at which investment and income grow so that full employment level is maintained over a long period of time by considering both demand and supply side of the economy (Gupta, 2008).

A common prediction of the exogenous growth model is that an economy will always converge towards a steady state rate of growth[3] which depends only on the rate of technological progress and the rate of labor force growth. Furthermore, it predicts that physical or human capital accumulation can affect growth only during "transitional" periods when the economy is out of its steady state (Mankiw *et al*, 1992). The theory also predicts that, out of steady-state, poorer economies would tend to grow faster than rich ones, given the effect of diminishing returns to capital. In this context, policies including fiscal policies cannot permanently affect economic growth, since they cannot change the rate of savings. However, the limitations of the exogenous growth model have been gradually relaxed in the literature with the development of endogenous growth model by Romer, (1986 and 1990) and Lucas (1990) which captured the impact of human capital accumulation and research and development expenditures on growth.

The Endogenous Growth Theory

The endogenous growth model developed by Romer and Lucas (1990) will be the main material discussed in this section. The endogenous growth model goes deeper into the question on the ultimate sources of growth and provides a superior justification of growth over time. The emergence of this new growth theory addresses some of the shortcomings of the neoclassical growth theories. Notably, in addition to labour, capital and technology it identified the importance of fiscal policy instruments as an important source in determining output growth. Further, the theory explained the determinants of economic growth by excluding two main assumptions that were incorporated in the neoclassical growth model. The first assumption is that technological change is exogenous, and that it determines the growth rate beyond its steady state. The second assumption is that the same technological opportunities are available to all countries. The theory further explains that the long run economic growth is determined by factors that are internal to the economic system, mainly those factors which create opportunities and inducement to generate new technological knowledge.

[3] Robert Solow and Trevor Swan applied the term steady state a bit differently in their economic growth model and they implied that steady state occurs when investment equals depreciation, and the economy reaches equilibrium, which may even occur during a period of growth.

Although the neoclassical growth model emphasised that fiscal policies cannot bring changes in long term growth of output, the endogenous growth model provided a theoretical basis for how fiscal policies can affect the long term growth rate (Barro and Sala-i-Martin, 1992)[4]. Because of market failure, government's fiscal policies can improve factor allocation among different sectors of the economy and thereby privately owned factor productivity and the accumulation of physical as well as human capital also can be increased. The endogenous growth model explained the productivity of growth through various economic incentives. The first strand of this approach emphasises the formation of human capital, including the acquisition of skills and training of workers. A second strand focuses on research and development activities of firms. The third strand focuses on granting of patent rights to ensure temporary monopoly to the inventors of new products (Gupta, 2008). An implication of this theory is that the saving rate can affect the long run growth. The model further emphasises that technological progress takes place through various channels such as innovations, mainly in the form of new products, new processes and new markets which are mainly as a result of on-going economic activities. Similarly, the research and development expenditures undertaken by firms, and implementation of economic policies such as fiscal and trade policies with regard to education, trade, taxes, competition, and intellectual property are some of the other factors throughout which the rate of innovation can be influenced via affecting the costs and benefits of research and development activities. The main implication of this endogenous growth theory is that, government policies, including fiscal policies, can affect the long run growth rate by changing economic agent's motivations to save, invest, and accumulate human capital. While most of the growth models predict that taxes on investment and income have a negative effect on growth, these taxes affect the rate of growth through diverse channels. In particular, they reduce private returns to accumulation. However, all taxes do not affect the rate of growth negatively. In the endogenous growth model, it is argued that taxes and social contributions can hinder growth by distorting the decisions of a representative household that maximises utility over time with respect to income such as savings and investment decisions or decisions concerning the trade-off between leisure and labour.

According to the endogenous growth model, tax policies are used not only to intervene to correct non Pareto optimality states but are also used in pursuing active policies to maintain long run economic growth (Arisoy and Unlukaplan, 2010). Taxes on international trade also have potential negative impacts on growth. In particular, when imposing taxes on capital and intermediate goods, the relative price of both inputs will

[4] Public inputs, natural monopolies or spill-over effects are the main justifications for government intervention in to the economic activities.

fall, and thus reduces the steady state marginal rate of return on these inputs. These theoretical explanations suggest that the levels of taxes as well as their structures are crucial for growth. Hence, in order to minimise the negative impacts of the taxation, the distortion from taxes should be kept to a minimum in fiscal adjustment strategies through shifting the burden of taxation from investments and/or international trade to domestic consumption (Eken, *et al*. 1997).

2.2 Empirical Evidence

Over the decades, a number of studies have attempted to explore the variable which could properly capture the best fiscal stance of an economy. Out of the three standard fiscal policy variables: government spending, taxation and deficits, the literature does not indicate any one of these as the most representative. While many researchers have made use of tax rates as a proxy for fiscal policy (Lucas, 1990; Engen and Skiner, 1996) others such as Martin and Fardmanesh (1990) and Easterly and Rebelo (1993) have used fiscal deficits to represent fiscal policy in their estimation procedures. Yet others (Barro (1990), Aschauer (1985), Easterly and Rebelo (1993) have used expenditure to account for fiscal policy. However, this section reviews some empirical literature which examined the possible impact of taxation on output growth.

Easterly and Rebelo (1993) examined the relationship among fiscal policy variables, growth rate and development using cross-sectional data over the period 1970 to 1988 in 160 countries and by employing Barro's (1991) cross section regression model. They argued that there is a strong relationship between the development level and the fiscal structure. In particular, they showed that while fiscal policy is only influenced by the scale of the economy, the investment in transport and communication is strongly and positively correlated with the growth rate. However, the overall findings showed that it is difficult to isolate the affects of taxation on growth empirically.

Dowrick (1992) also estimated how taxation could affect the economic growth during the period 1960 to 1985 for selected Organization for Economic Co-operation and Development (OECD) countries and argued that while personal income taxation had significant negative impacts on economic growth, corporate taxes did not. Evans (1997) also examined the impacts of taxation on growth employing panel data for 11 OECD countries. The study found that adjustments of tax rates cannot be associated with permanent changes of real GDP growth, unless permanent changes in taxes are cancelled out by permanent changes in other policy variables. However, the author's findings emerged while excluding the expenditure side of the budget from his analysis. Mendoza *et al* (1997) showed using panel data for 18 OECD countries for the period of 1966 to 1990 that while tax composition has significant impacts on private investment

it had no significant effect on economic growth. Folster and Henrekson (2001) noted that average tax rates and the ratio of government expenditure have strong negative effects on economic growth rates using panel data from Organization for Economic Cooperation and Development (OECD) countries during the period 1970 to 1995. The study further showed that countries that have higher average income tax rates experienced lower output rates whereas countries with lower average income tax rates recorded higher output levels.

Lee and Gordon (2005) showed using both cross sectional and panel data regression in 70 countries over the period 1970 to 1997, that corporate tax rates have significant negative impacts on economic growth rate and therefore concluded that a reduction in corporate tax rate of 10 percent would enhance the annual growth rate nearly by one to two percent. Easterly and Rebelo (1993) used cross country data in developing countries and found that differential taxes and tariffs significantly affected the prices of capital goods and therefore, the variance in the relative prices of capital goods have strong negative impacts on growth rate and slows down the economic growth. Engen and Skinner (1992) developed a generalized model of fiscal policy and economic growth to identify the impacts of fiscal variables on growth rate using data from 107 countries over the period 1970 to 1985 and found a significant and negative impact of government fiscal activity on economic growth rate in both short and long run. Further, the authors argue a 10 percent increase in tax reduces output growth by 3.2 percent annually.

Kneller, Bleaney and Gemmell (1999) showed that an increase in productive expenditure has positive impacts on growth when that expenditure is financed by non-distortionary taxation. However, he noted that an increase in distortionary taxation reduces growth rates significantly. Eken *et al* (1997) examined the impacts of fiscal policy on economic growth in the Middle East and North African regions during 1980 to 1995 and concluded that reductions in budget deficit; improvements in budgetary structure and effectiveness of government interventions are playing a key role in macroeconomic stability and promoting growth. In a study of the impacts of tax reform on economic growth, Engen and Skinner (1996) showed the negative impacts of tax rate on economic growth. Specifically, they considered the impacts of a 5 percent reduction in marginal tax rate on long run economic growth. The study found that there are 0.2 to 0.3 percent differences in growth rate due to major tax reform. The study also concluded that despite the fact that impacts of tax reform on economic growth may be small, yet such small effects can have large impacts on living standards.

Myles (2009) analyzed the effects of the overall tax burden on growth using cross-country growth regressions. The empirical evidence showed that the net balance of the positive and negative effects of taxation on economic growth differs both across

countries and over time. Ocras (1999) examined the effects of selected fiscal policy variables such as government consumption expenditure, investment expenditure, deficits and tax receipts, on economic growth over the period 1990 to 2004 using quarterly data from South Africa. The study concluded that although investment expenditure had a positive impact on growth, the size of the impact was less than the impact of consumption expenditure. Further, the study revealed the positive effects of tax receipts on growth. However, it was found that the size of the budget deficit does not have a significant impact on growth.

Jayawickrama (2008) estimated the resilience parameters of tax functions in Sri Lanka over the period 1980 to 2005. Results showed that the long run responsiveness to income is absolutely low in corporate income taxes. Further, the study indicated that personal income, excise and import taxes are growing in relation to their tax bases. According to the estimated results, the author emphasises that the low buoyancy of corporate income tax and the susceptibility of general goods and service tax to unexpected non-structural shocks are the main causes for the declining revenue-gross domestic product (GDP) ratio in Sri Lanka.

3. Data, Model and the Methodology

3.1 The Data Set[5]

This study uses time series annual data for the period 1980 to 2013 to coincide with the adoption of economic liberalisation policy in Sri Lanka. All the data were obtained from various issues of the annual report of the Central Bank of Sri Lanka. Further, the study uses data on tax revenues to estimate the impacts of distortionary and non-distortionary taxation on output growth. The theory also indicates that while distortionary taxes have significant impacts on growth, non-distortionary taxation has an insignificant impact on growth. Hence, for the purpose of identifying whether tax structure adjustment associated with the output level, the study considered both aggregate as well as disaggregated data for taxation[6].

3.2 Theoretical Model: Barro's Growth Model

Lucas (1988), Barro (1990) and Rebelo (1991) are some of the studies that provide theoretical arguments to support the importance of policy variables in determining economic growth. Barro (1990) explained the relationship between fiscal policies and growth. This study employs Barro's (1990) growth model in examining the implications of tax policies on economic growth in Sri Lanka. More specifically, the

[5] The lists of variables considered in this study are reported in appendix Table 1.
[6] Government tax revenue as a percentage of GDP was considered as a proxy for the taxation.

study attempts to incorporate fiscal as well as non-fiscal variables into the growth model. The assumption in the Barro growth model is that government supported goods and services play an important role from an input to output level. Barro identifies four categories of public finances in order to examine the importance of fiscal policy variables on growth determination; productive expenditures, non-productive expenditures, distortionary taxation, and finally non-distortionary taxation. The detailed explanation on these categories are given below.

Productive and Unproductive Expenditures: Barro (1990) assumed that government expenditure can be treated as productive (growth inducing) when it comes into the production function by contributing directly to output level. If not, it is considered as unproductive expenditure (growth retarding) and does not have any permanent effect on the output level. Corresponding to these explanations, government's consumption expenditure is treated as 'unproductive' because it affect only the consumers' welfare but does not affect the efficiency of private production. Investment expenditure, on the other hand, is treated as 'productive' since it directly affects the output level. At the same time, expenditure on education and health can also be treated as productive because of their effects on human capital accumulation. However, the growth effects of public expenditure on current transfers such as social security remain a questionable issue. However, if these expenditures are merely affecting the welfare; then these expenditure categories can also be treated as 'unproductive' expenditures. On the other hand, transfers may affect savings rates and inequality etc. and could then be either growth enhancing or hindering. Hence, the growth effects of these expenditures, depend on how these expenditures are utilised in the economy.

Distortionary and Non-distortionary Taxes: In Barro's (1990) growth model, 'distortionary' taxes are those which affect investment decisions of investors, in particular, income taxes which can affect the level of output negatively. On the other hand, taxes such as consumption taxes are generally considered as non-distortionary. However, human capital investment can be affected by consumption taxes when labour supply is endogenous (Mendoza *et al,* 1997). Generally, in practice, nearly all taxes are distortionary to some extent. Hence, the long term effects of taxes can be used to identify whether the distortions which resulted from the implementations of various types of taxes can be expected to be significant or not with respect to the main determinants of the long term economic growth such as investment, education and technology.

According to the Barro model, while distortionary taxation discourages investment in physical and human capital the non-distortionary taxation does not affect the incentives driving such decision making. Furthermore, this model has laid out the channels

through which tax policy changes affect the output growth (Barro, 1990; King and Rebelo, 1990). The model indicated that the changes in the tax policy not only affect output growth during the short run adjustment process, but it could also have a permanent effect on long term output growth. Meanwhile, the model demonstrates that while productive public expenditures have a positive impact on output level, distortionary taxes on the other hand have a negative impact on output level. According to these arguments, the aggregate production function which depicts how the factor inputs determine economic growth is given as;

$$y = Ak^{1-\alpha}g^{\alpha} \dots\dots\dots\dots\dots\dots (1)$$

where k represents privately accumulated physical capital and g is government expenditure (public capital) that directly comes into production. Therefore, there is a constant return to total capital inputs which includes public and private capital (k+g). A is an indicator of technology that captures the total factor productivity (TFP).The government also produces consumption goods for people which is unproductive and is considered not to have any effect on the output level. It is also assumed that the government annually balances its budget by imposing proportional taxes on output at a given rate and by imposing lump-sum taxes. Hence, the government's budget constraint requires balancing expenditures and revenues in every period in the long run which can be specified as:

$$g + G_0 = \tau.Y + T_0 \dots\dots\dots\dots\dots\dots (2)$$

Where, G_0 represents government expenditures that are not directly entered into the production function as inputs, T_0 represents lump-sum taxation which is non-distortionary with the level of output and τ is a proportional tax on output which can distort the investment decision of the private sectors and investors.

According to the Barro (1990) model, the growth rate of consumption and output in the steady state can be expressed as:

$$y = \frac{\dot{c}}{c} = \frac{1}{\theta}[A^* - \beta] \dots\dots\dots\dots\dots (3)$$

Where,

$$A^* = (1-\tau)(1-\alpha)Ak^{-\alpha}(g)^{\alpha}$$

Equation 3 expresses that growth in output and consumption depends on the gap between the marginal product of capital and the rate of time preference (β), and $\frac{1}{\theta}$. $\beta, and\ \theta$ are parameters in the growth model. The higher θ is the higher returns to capital (MPK) which encourage investment and in turn raises the growth rate of consumption and thereby raises output. The above Barro (1990) model 4 predicts that

productive government expenditure and distortionary taxation as a share of output positively and negatively affect the long-run growth rate while unproductive expenditure or lump-sum taxation does not have any significant negative effects on output growth in the steady state. Further, the above model indicates that the growth rate is decreasing according to the rate of distortionary taxes and increasing in line with government productive expenditure. However, it is noted that the growth rate is unaffected by both non-distortionary taxes and by the unproductive expenditure. These explanations indicate that fiscal variables from both sides of the budget constraint matter for growth, and therefore failure to include both productive government expenditures and distortionary taxation in the growth model would lead to misspecification.

$$y = \frac{\dot{c}}{c} = \frac{1}{\theta}[(1-\tau)(1-\alpha)Ak^{-\alpha}(g)^{\alpha} - \beta\,] \dots\dots\dots\dots\dots (4)$$

Equation 4 illustrates that government affects the marginal product of capital through two channels. Firstly, increase g which raises the marginal product of capital (MPK). Secondly, taxation which can reduces the private return to capital. Hence, the government needs to concentrate on balancing these two effects.

$$MPK = (1-\tau)(1-\alpha)Ak^{-\alpha} \qquad g^{\alpha} \dots\dots\dots\dots\dots (5)$$

Where, $(1-\tau)$: Negative effect of taxation

g^{α} : Positive effect of public services

Table 1 exhibits the growth effects of taxes and expenditure. Generally, the growth effects of public expenditure and taxation are not only dependent on size and type but they also depend on how the deficit is financed. Similarly, growth rate is not only a function of relative productivity of public expenditure but it is also a function of the relative shares of these components in total public expenditures (Gemmell, 2001). Hence, despite all public expenditure being assumed to be productive[7], an application of distortionary taxes at a high level to finance the deficit may generate a negative impact on the growth rate. Therefore, in order to make use of the Barro model in the empirical analysis (when estimating the growth effects of public expenditure and taxation) it is crucial to incorporate the growth stimulating potential of individual expenditure and revenue components into the long run growth model.

[7] Productive expenditure is the component of public expenditure which raises the steady state growth rate of the economy (Deverajan et al. 1996, p.317).

Table 1: Growth Effects of Taxation and Public Expenditure

Financed By		Public Expenditure	
		Productive	Unproductive
Taxes	Distortionary	Positive / Negative	Negative
	Non-Distortionary	Positive	Zero

Source: Gemmell, 2001.

This study will use the above predictions as a basis to interpret the observable pattern of economic growth and fiscal policy instruments. Similarly, the study uses data on economic categorizations of government revenue in order to compute more precisely the effects of distortionary and non-distortionary taxation on the growth rate. This is relatively uncomplicated with respect to taxation, because the classification of direct taxation on property and income, on the one hand, and indirect taxation on imports and production on the other hand, largely reflects the theoretical distortionary/non-distortionary classification (Avila and Strauch, 2008).

$$y_t = \alpha + \sum_{j=1}^{m} \gamma_t X_{jt} + \sum_{i=1}^{k} \beta_t Y_{it} + \sum_{j=1}^{n} \eta_t Z_{jt} + \varepsilon_{jt} \dots\dots\dots\dots\dots (6)$$

The present study considers both fiscal as well as non-fiscal variables in the growth model which are represented in equation 6. Where, y is the growth rate of output, X is a vectors of fiscal variables, and Y is vectors of non-fiscal variables. Z is vectors of control variables. ε_{jt} is the white noise error term. In this model, while investment to GDP ratio is considered as a proxy for the physical capital, education expenditure was taken as a proxy for the human capital input. Endogenous growth theory implies the existence of a balanced budget and therefore;

$$\sum_{j=1}^{m} \gamma_t TREV_{jt} = \sum_{l=1}^{n} \delta_t TEXP_{jt} = 0$$

Furthermore, for productive expenditures, the theory suggests that,

$$\sum_{l=1}^{n} \delta_t TEXP_{jt} > 0$$

And for distortionary taxation,

$$\sum_{j=1}^{m} \gamma_t TREV_{jt} < 0$$

The coefficient on each variable in the model is interpreted as the effect of a percentage change in the related variable offset by a percentage change in the omitted category on the dependent variable. Moreover, the coefficients of γ, β and η captures the long run effects of fiscal, non-fiscal and control variables on output growth.

3.3 Methodology

This study employs econometric techniques of multivariate cointegration and Vector Error Correction Model (VECM) to examine the dynamic relationship among the selected variables. This approach can capture the short run and long run equilibrium dynamics among the variables unlike a simple regression which only reveals the correlation between variables. In practice, as most of the economic times series variables behave as stochastic trends, the first step towards analysis on impacts of taxation on output growth involves the test of stationarity of all the variables. The standard regression models with non-stationary data can lead to the problem of spurious[8] relationships. Hence, in order to avoid the spurious relationship problem, the difference of the variables has to be included in the cointegration analysis. The test for stationarity[9] of the individual series in this study has been tested by applying both the Augmented Dickey Fuller (ADF) and Phillips-Perron test.

Furthermore, this study adopts Johanson and Juseliues (1990) method to test for long run cointegration. This method requires that variables entering the cointegration relationship to be integrated of the same order. The two likelihood test statistics known as trace and maximum Eigen value statistics which estimate the number of cointegrating vectors in cointegration procedure will be applied in this study. Moreover, the optimal lag length choice was made by examining the lag structure in an unrestricted VAR using VAR lag order selection criteria. In this respect, the final VAR models will be based on the criteria of Akaike information criteria (AIC) or Schwarz information criteria which minimize the overall sum of squared residuals. If the variables in the underlying regressions are found to be cointegrated, the cointegration approach will be extended to the employment of VECM. The VECM will be estimated

[8] Spurious relationship problem can occur when two time series variables in a regression are highly correlated whereas there is no actual relationship between them. High correlation is due to the existence of a time trend in both time series (Granger and Newbold, 1974).

[9] A time series is considered to be stationery if its mean and variance are independent of time. If the time series is non-stationary, it is said to have a unit root. Therefore the stationary of a time series is examined by conducting the unit root test.

to determine the short run dynamics of the regression model. Further, the coefficient of error terms are expected to capture the adjustments of the dependent variable towards long run equilibrium showing the speed of adjustment to the long run solution that enters to influence short run movements in growth, while the coefficients of other independent variables are expected to capture the short run influence on economic growth. The study also uses Ganger causality test to identify any causality among the variables.

4. Tax Structure and Development in Sri Lanka

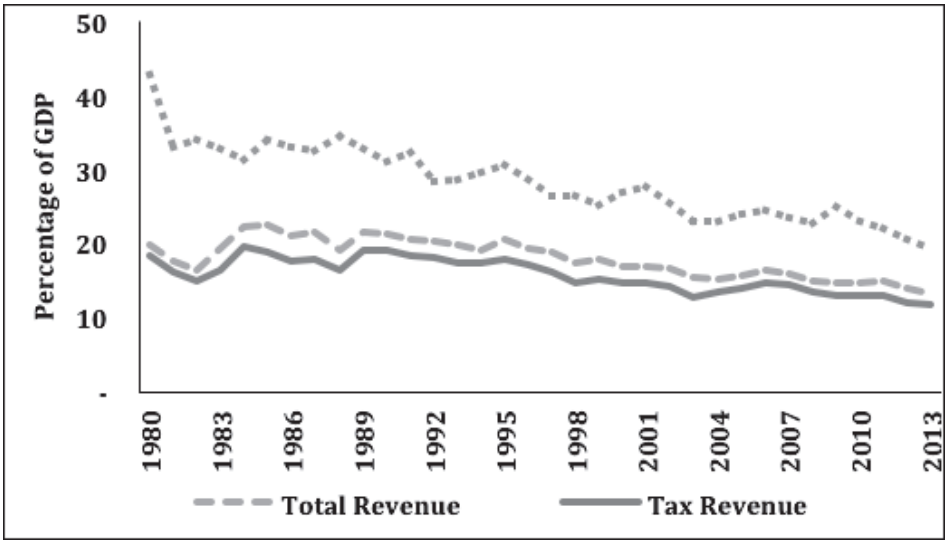
Taxation is a fundamental instrument used by the government to raise revenue for its public expenditure and helps in acquiring sustained growth targets. Similarly, taxes affect economic growth rates in numerous ways: discouraging savings and investment and entrepreneurship decision making by individuals and firms, discouraging work effort and workers' acquisition of skills etc. Tax policy such as direct taxes might distort capital accumulation and thereby reduce the growth rate permanently, while on the other hand indirect taxes which only distort consumption level, would keep capital accumulation and growth unchanged. In particular, taxes imposed on reproducible factors such as physical and human capital, are the most important examples of taxes that reduce the rate of economic growth. In a closed economy, a general consumption tax is a distortionary way of taxing labour, while excise taxes are either Pigouvian taxes, or they distort the allocation by driving wedges between the marginal rates of substitution and the marginal rates of transformation for consumer goods (Christiansen. *et al*, 1994). In this regard, taxation policy can be used to achieve the fiscal policy goals of fair distribution of income and wealth, efficient resource allocation and economic stabilization *etc*. (Musgrave, 1989).

Over the decades, with the change in the development strategy, the conventional way of generating revenues in many developing economies has changed. The new approach that many developing economies adopt was minimizing the level of distortions which are generated by tax policies in order to keep the economy more competitive. Besides, these economies also undertake tax reforms to advance their tax system and also to meet the requirements of international competition (Rao, 2002). Meanwhile, it has been widely recognized in both developed and developing economies that countries which have allocated higher expenditure to both education and health sectors were able to enhance their human development indicators. Governments however cannot increase these expenditures unless they are able to generate adequate revenue. Although there are several measures such as money creation, mandating larger required reserves, domestic borrowings and foreign loans which can be generally used to finance government's expenditures, these could have negative macroeconomic consequences

(Amirthalingam, 2010). Therefore, in order to finance these expenditures, government has to collect revenue from various sources in a way that is equitable, which can improve social welfare and does not distort the structure of price incentives.

The tax reforms undergone in Sri Lanka involve significant changes over the years in keeping with the changing role of different political parties. Sri Lanka embarked on tax reform to revamp its tax systems and to increase its revenue in the face of growing government expenditure and declining tax revenues. However, successive governments of Sri Lanka have provided a number of concessions in the form of tax exemptions and tax holidays to attract more private investment into the economy. At the same time, with the objective of financing increasing public expenditure, the government needs to gather more revenue from various sources such as direct and indirect taxation, surpluses from public enterprises, licensing fees, earnings from the holding of assets and foreign aid (de Silva, 1992). In Sri Lanka, over the decades, despite the economy experienced with high level of output growth and the significant rise in imports, it can be seen that the total government revenue to GDP ratio continuously declined as a result of the abolition of several taxes, the lowering of tax rates and the extension of exemptions (CBSL, 2011).

Figure 1: Government Revenue and Expenditure in Sri Lanka



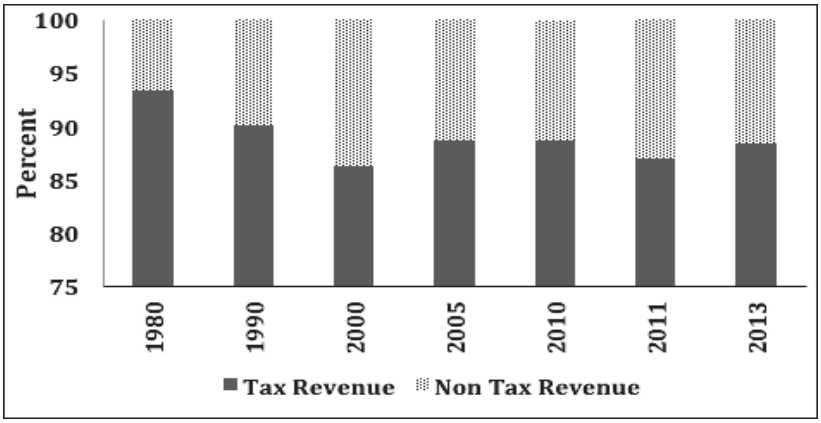
Source: Central Bank Annual Reports (Various Issues)

The total revenue as a percentage of GDP during the 1970's was on average 20 percent, and this ratio increased to 21.1 percent during the 1990s. However, Since

the 2000s, it started to show a declining trend and in 2010 was merely about 14.6 percent of GDP (see the figure 1). Similarly, total expenditure shows a declining trend and the gap between total expenditure and revenue remained relatively stable over the period. Against this backdrop, the continued high fiscal deficits[10] would not only increase concerns about the overall sustainability of the fiscal situation, but would also result in upward pressure on interest rates, and crowd out private investments (World Bank, 2010).

Generally, tax revenue is a major source of total public revenue in many developing economies including Sri Lanka, where nearly 90 per cent of the total revenue is generated through taxation (CBSL, various issues). However, although the tax revenue in absolute terms is continuously increasing as a result of higher revenue from income based taxes, excise duties and import related taxes, it could also be found that tax revenue as a percentage of GDP has continuously declined. During the post economic liberalisation period, the tax revenue was nearly about 82.4 percent of total revenue while the rest is non tax revenue. Since 1990s, however, this trend has changed significantly. In particular, non-tax revenue as a percentage of total revenue increased from 6.6 percent in 1980 to 9.9 percent in 1990 while tax revenue as a percentage of total revenue decreased from 93.4 percent to 90.1 percent in 1990. Similarly, by 2013, while tax revenue was approximately 88.4 per cent of total revenue the rest is non tax revenue. Non-tax revenue increased mainly due to income from profit transfers of public institutions.

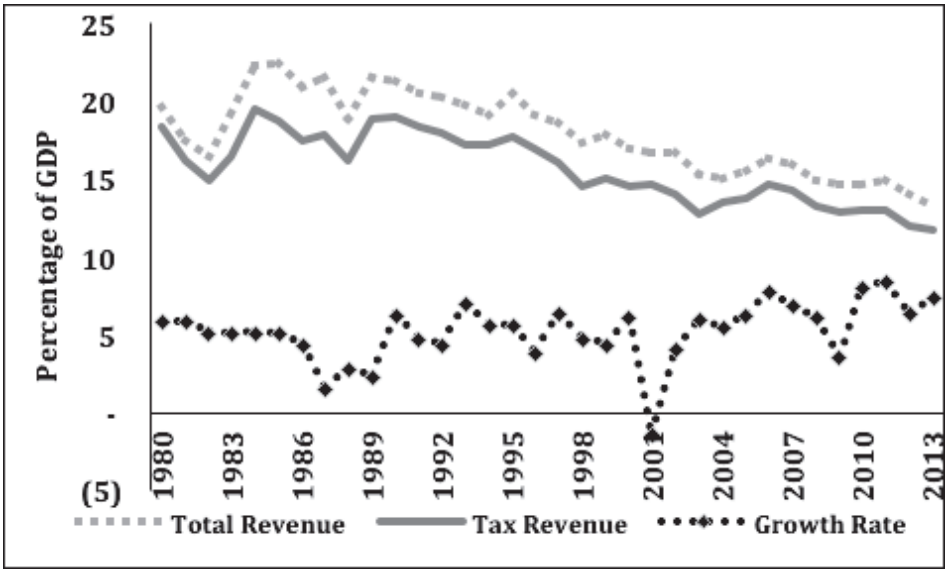
Figure 2: Decomposition of Government Revenue in Sri Lanka



Source: Central Bank Annual Reports (Various Issues)

[10] The international evidence suggests that large fiscal deficits are probably the primary cause of macroeconomic instability in most of the economies.

Figure 3: Government Revenue and Output Growth in Sri Lanka



Data Source: Central Bank Annual Reports (Various Issues).

Figure 3 shows the trend of tax revenue as a percentage of GDP in Sri Lanka between 1980 and 2013. The trend shows two distinct phases. Firstly, from 1980 to 1990, there has been a stable increase in the tax revenue to GDP ratio in keeping with the economic conditions and acceleration in the growth rate of the economy. The tax ratio, which was about 15.1 percent in 1977, increased steadily to 18.7 percent in 1985. Further, the ratio continued to increase until the early 1990s and reached a peak of 19 percent of GDP in 1990. At the same time, the growth rate also increased from 4.2 percent in 1977 to 6.2 percent in 1990. However, thereafter, despite the economy reaching a reasonable level of growth rate, the tax revenue as percentage of GDP started to decrease gradually. Following further economic liberalisation in the 1990s and the subsequent reforms in the tax system, mainly the reduction in import tariffs has resulted in a decline in the tax to GDP ratio. Moreover, reduction in both quantitative restrictions and tariff levels with the intention of promoting exports has also resulted in a decrease in total revenue as a percentage of GDP. Hence, despite the tax ratio peaking at 19 percent in the early 1990s, the ratio declined thereafter continuously and recorded 13.7 percent in 2005 and 12.4 percent in 2011. The main reason for the declining tax revenue-to-GDP ratio was a fall in import duties, as tariffs were lowered. In this context, given that Sri Lanka is currently a lower middle income country; the tax revenue is undoubtedly insufficient from the perspective of the resource necessities of the economy.

Table 2: Government Revenue in Selected Countries

Countries	1990	1995	2000	2005	2010	2013
Bangladesh	6.8	9.8	8.5	10.6	9.5	10.7
Bhutan	18.8	19.1	23.2	17.0	27.4	–
India	10.7	9.9	9.8	9.7	10.6	9.4
Maldives	–	25.8	30.0	29.8	23.4	32.6
Nepal	8.4	10.4	10.5	11.9	15.1	17.5
Sri Lanka	21.4	20.6	16.4	15.5	14.6	13.1
Malaysia	24.8	22.9	17.4	19.6	20.0	21.7
Thailand	17.5	18.1	14.7	17.4	16.8	18.2
Pakistan	19.3	17.3	13.4	13.8	14.0	9.5
Vietnam	14.7	21.9	20.1	25.7	26.7	21.9

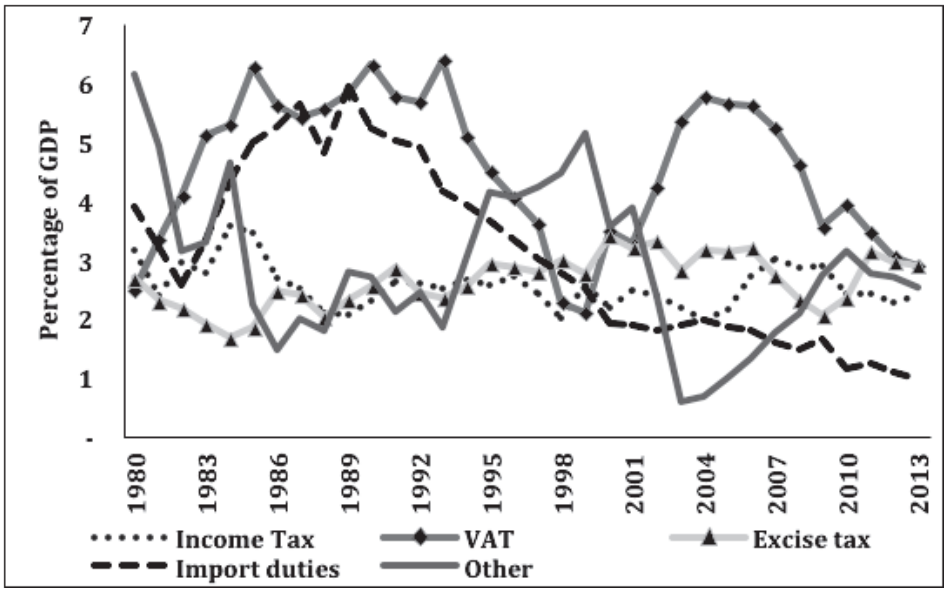
Source: Key Indicators for Asia and the Pacific 2014

Table 2 presents the trend of government revenue as a percentage of GDP in selected countries from 1990 to 2013. This general picture shows significant differences between countries. From a regional perspective, public revenue-to-GDP ratios in Sri Lanka have been relatively low over the period. It is lower than those of Malaysia, Thailand, Vietnam and Nepal by a large ratio. India and Pakistan's public revenue roughly follows a similar pattern. However, the revenue to GDP ratio in Sri Lanka dropped significantly from 21.4 percent of GDP in 1990 to 15.5 percent of GDP in 2005 and it further decreased gradually to 13.1 percent of GDP in 2013. In Bangladesh, total revenue was only 6.8 percent of GDP in 1990s, and this has merely increased to 10.7 percent in 2013. In India, during 1990s the revenue was 10.7 percent. This decreased to 9.8 percent of GDP in 2000 and gradually decreased to 9.4 percent in 2013. It is also noted that the revenue situation in Pakistan during the 1990s was 19.3 percent, but this has decreased to 13.4 percent in 2010 and again further decreased to 9.5 per cent in 2013. Therefore, the data presented in the above table clearly illustrate that public revenue in Sri Lanka continues to be considerably lower than the selected regional counterparts during the last three decades. Hence, the authorities in Sri Lanka need to prioritise the increasing of public revenues in future to cover increasing expenditure.

In practice, while developing economies are very much dependent on indirect taxes compared to direct taxes, developed economies on the other hand depend a lot on direct

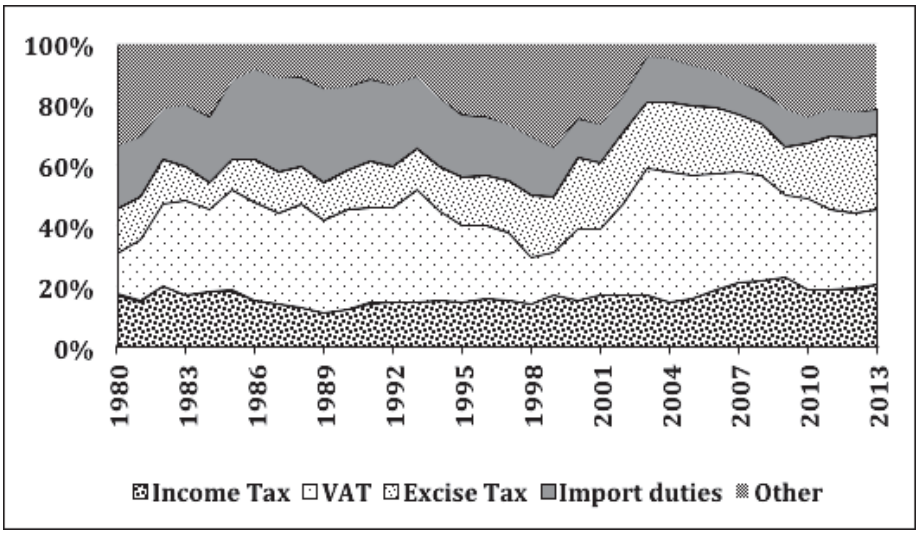
taxes for revenue generation. Apart from taxes on domestic goods and services, trade taxes plays a more vital role in generating revenues in developing economies than in industrial economies. Domestic taxes on sales are used to influence the pattern of consumption. On the other hand, trade taxes such as import duties are used to influence the pattern of imports. Figure 4 shows how the tax revenue varies over time. Each tax component in figure 5 is expressed as a share of total tax revenue. The figure shows the significant difference between the taxes. Specifically, it indicates that only about one fifth of total taxation is owing to income taxes. Further, the figure shows that there has been a decline in the share of income taxes from 3.1 per cent in 1980 to 2.6 per cent in 1995 and then to about 2.4 per cent in 2011 (See the figure 4).

Figure 4: Trends in Tax Revenue in Sri Lanka: Disaggregated Analysis



Source: Central Bank Annual Reports (Various Issues)

Figure 5: Composition of Tax Revenue in Sri Lanka



Source: Central Bank Annual Reports (Various Issues)

Following economic liberalisation in 1977, it can also be noted that the revenue from indirect taxes fell relatively faster than the revenue from other taxes.[11] With the significant reduction in import duties, the revenue from import duties gradually reduced to 4.4 per cent of GDP in 1980 to 3.6 per cent in 1995 and 1.2 per cent in 2011. Although the share of revenue from import duties has declined due to the reduction in the tariff barrier, a decline can be seen in the share of revenue from excise taxes, though at a slower rate. However, the growth of tax revenues can be seen in the form of an increase in indirect taxes imposed on goods and services (VAT)[12] which is considered the primary source of revenue in the economy. Domestic sales taxes have continually increased from 2 percent in 1977 to 6.3 per cent in 1990 and reached a peak of 10.6 per cent in 1995. Subsequently, however, it started to decline continuously and was 5.7 per cent in 2005 and 3.3 per cent in 2011. On the other hand, contributions from excise taxes are also identified as an important source of tax revenue in Sri Lanka, where they

[11] Other taxes refer Ports and Airport Development Levy (PAL), Environment Conservation Levy (ECL), Regional Infrastructure Development Levy (RIDL), and the Social Responsibility Levy (SRL).

[12] Value Added Tax (VAT) was introduced in 2002 and replaced the Goods and Services Tax (GST) which was almost similar to the tax on the consumption of goods and services (GST was introduced in 1988). Prior to GST, Business Turnover Tax was in place (BTT was introduced in 1963 under Finance Act 11 of 1963).

are equivalent to or even exceed the share of direct income taxes. Further, the other taxes as a percentage of GDP have been continually increasing since 1997. Hence, it can be noted that one of the prominent features of the tax system in Sri Lanka is the low level of revenue from direct taxation in total tax revenue. During last three decades, the average revenue from income taxation including personal, corporate and withholding taxes was only about 2.5 per cent of GDP. The main reasons for this situation are the narrow base of the income tax, the low coverage, the rate structure, low compliance, tax evasion and the number of tax holidays and exemption.

5. Empirical Estimates of Taxation and Output Growth

In this paper, the total tax revenue is divided into five major components namely income tax, consumption tax (VAT), excise tax, import duties and other tax revenue. The results of ADF and PP unit root tests are presented in Table 3. Accordingly, the null hypothesis of unit root cannot be rejected at levels for all the variables. Nevertheless, the results indicate that the series are stationery when they are transformed in to first difference form.

Table 3: Test of Unit Root[13]

Variables	ADF		PP		Order of Integration
	Level	First Difference	Level	First Difference	
HC[14]	-3.0675	-7.6132*	-3.0421	-18.2062*	I (1)
PC[15]	-2.3179	-4.6282*	-4.6963	-12.8656*	I (1)
PPG	-6.0050	-9.0067*	-2.2324	-8.1562*	I (1)
TREV	-3.7218	-5.8029*	-2.2514	-11.4403*	I (1)
EG	-2.6405	-6.2759*	-2.6248	-6.2758*	I (1)
EXT	-2.9140	-5.6699*	-3.0090	-7.8137*	I (1)
IMD	-1.9195	-4.7365*	-1.9194	-4.7137*	I (1)
INT	-2.8843	-7.1488*	-2.5772	-7.1191*	I (1)
M2b	-3.1547	-6.3489*	-3.1623	-8.1213*	I (1)
OTR	-3.4568	-4.6593*	-2.5171	-4.6842*	I (1)
TTR	-3.7217	-5.8029*	-2.2514	-11.4403*	I (1)
VAT	-2.8871	-5.7914*	-2.8538	-9.5657*	I (1)

Note: ***, **, and * imply the rejection of the null hypothesis at significance level of 10%, 5% and 1% respectively.

[13] The number of lag selection was based on AIC (see the appendix, Table 2).
[14] Education expenditure as a percentage of GDP was taken as a proxy for the Human Capital.
[15] Investment as a percentage of GDP was taken as a proxy for the Physical capital.

The Johansen and Juselious (1990) co-integration test was adopted to examine the existence of long run association among these variables. The trace and maximum eigen-value statistics were used to test the null hypothesis of no co-integration. Table 4 reports the results of Johansen's cointegration tests for the null hypothesis of at least one co-integrating vector among economic growth, and fiscal as well as non-fiscal variables. The Johansen cointegration test shows the existence of one cointegrating vector among economic growth, physical capital, human capital, total public expenditure and all sub categories of total government revenue while both tests reject the null hypothesis of no cointegration with one cointegrating vector. Hence, it could be concluded that there is strong evidence to support the existence of a long run association between economic growth and government revenue. This is not an unexpected outcome as Sri Lanka largely depend on tax revenue to meet its expenditure and to achieve sustainable growth.

Table 4: Johansen Test for Cointegration

	Test Statistics		0.05 Critical Values	
Hypothesized No. of CE(s)	Trace Statistic	Max-Eigen Statistic	Trace	Max-Eigen
None **	105.1877	42.3812	95.7537	40.0775
At most 1	62.8065	23.5802	69.8188	33.8768
At most 2	39.2262	17.4161	47.8561	27.5843
At most 3	21.8102	11.1105	29.7971	21.1316
At most 4	10.6997	10.3394	15.4947	14.2646
At most 5	0.3603	0.3603	3.8415	3.8415

** denotes rejection of the hypothesis at the 0.05 level

Note: Trend assumption: Linear deterministic trend[16], Lags interval (in first differences): 1 to 1;

However, overall taxation does not have significant impact on output growth (see the appendix table 4). In other words, it implies that not only the aggregate total tax burden but the structure of taxation also matters for growth. In general, some taxes are thought to be more distortionary than others as different taxes have more or less stable tax bases. For instance, high income taxation is often assumed to be more harmful for economic activities than taxation on consumption. This implies that various taxes have different effects on the level of economic activities. Furthermore, as the findings show that there is a long term cointegration among the series, the short run equilibrium of

[16] Cointegration equation includes economic growth, human capital, physical capital, tax revenue, and population growth.

these series should also be estimated in order to understand the response of these variables in the short run.

The short term coefficients are estimated using Vector Error Correction Model (VECM) and the results are provided in appendix Table 5. The results indicate that changes in tax revenue does not have any influence over short term growth. In particular, the VECM of economic growth in the study appeared statistically insignificant at the 5 per cent level. This indicates that short run deviations of economic growth cannot be explained by the changes in variables that have been included though there appears to be an indication of the presence of other determinants which could have significant influence over the determinant variable but which have not been captured in this study.

Table 5 presents the OLS estimates of long term coefficients. The first difference of series were included for the estimation. The model (1) presents the results of increase in income tax compensated by other tax revenue (tax neutral). Accordingly, the model indicates that an increase in income taxation has a negative and statistically significant impact on growth which supports our initial expectation. Notably, holding other variables of the model constant, a percentage point increase in income taxation is associated with approximately -0.06 percentage point decrease in long term growth. This result is consistent with the findings of Dowric (1992) and Folster and Henrekson (2001), who found a negative and statistically significant impact of income taxation on economic growth. There are several reasons for expecting a negative sign of income taxation. As income taxation includes both corporate and personal income taxation, an increase of these taxation lowers the return on innovations and reduces the amount spent on research and development activities which in turn affects growth negatively. Moreover, corporate taxation can discourages investment both domestically and internationally via reducing foreign direct investment, and thereby would hinder long term economic growth. Conversely, taxation on personal labor income could affect economic growth via influencing investment in human capital and entrepreneurial activities[17].

[17] The impact of the income taxes on entrepreneurial activities depends on how the income from this activity is taxed in individual sectors.

Table 5: Tax Composition and Output Growth

Depended Variable (GDP Growth)	Model 1	Model 2	Model 3	Model 4	Model 5
Baseline Model					
Physical Capital	0.3297***	-0.7039	0.3236***	0.2206**	0.3942***
	[3.0084]	[-1.009]	[3.2513]	[2.0676]	[3.7354]
Human Capital	0.4828	0.2511	0.3901	0.4957	0.4726
	[0.3918]	[0.5139]	[0.3369]	[0.4144]	[0.4247]
Population Growth	0.6981*	9.9730	0.7539**	0.8351	0.5455
	[1.8378]	[1.1731]	[1.9569]	[2.2853]	[1.5011]
M2b	0.1655	0.1019	0.0823	0.0742	0.1522
	[0.8194]	[0.8447]	[0.3812]	[0.3757]	[0.8382]
Control Variable					
Overall Tax Burden	-0.1279	-0.1351	0.2674	0.2448	-0.1002
	[-0.5612]	[-0.6526]	[0.0694]	[0.8667]	[-0.63302]
Tax Structure Variables					
Income Taxes	-0.0573**				
	[-1.9794]				
VAT		0.3285**			
		[2.3209]			
Excise Taxes			0.0985		
			[0.7781]		
Import Duty				-0.5576*	
				[-1.8112]	
Other Taxes					-0.0655**
					[-1.9689]
C	-5.2064	-6.7789	-8.0933	1.3311	-0.0382
	[-0.5676]	[-0.7910]	[-0.9773]	[0.1488]	[-0.0780]
R-squared	0.4242	0.4195	0.4339	0.4838	0.5410
DW Stat	1.9547	1.9061	1.8808	1.9566	1.9410

Note: *t* values are presented in the parenthesis.

*, **, and *** imply the rejection of the null hypothesis at significance level of 10%, 5% and 1% respectively.

The study found that the consumption taxes (VAT) appear to have a strong positive and statistically significant impact on growth (model 2). This implies that taxation on goods and services has improved the output growth in Sri Lanka. More precisely, holding other variables of the model constant, a percentage point increase in consumption taxes is associated with approximately 0.33 percentage point increase in long term growth. The positive impact of consumption taxes, notably, VAT could be considered to be more conducive to growth because of their effect on savings and on labor supply. VAT does not impose on savings while income taxes are imposed on savings and on the income from savings (interest). In this regard, consumption taxes such as VAT can encourage savings, leading to increased investment and growth. Also, VAT does not affect people's decisions about whether or not to work, while the income tax system, make people reluctant to work since a higher tax rate will be imposed when people work harder and earn more. Therefore, increase in consumption taxes such as VAT could have a positive impact on growth. However, despite the findings show that consumption taxes or indirect taxes have a positive impact on growth, continues decline in share of indirect taxes on overall tax revenue is still matters for sustainable growth and development. Hence, enhancing the efficiency and productivity of indirect taxation is crucial given the low tax revenue while taking measures to ensure equity in the economy.

In the case of international trade taxes which have been captured in model (4), the coefficient for output growth has a negative sign and is statistically significant at the ten per cent level. It is noted that the share of these taxes declined in response to trade liberalisation. The negative sign could be a result of imposing taxes on capital and intermediate goods which would result in the fall of the relative price of both inputs and thus reduce the steady state marginal rate of return to these inputs. Meanwhile, the results show that excise taxes have a positive impact on growth but are statistically insignificant.

Finally, our results for all other taxes in model (5) show that the coefficients for output growth carry a negative and statistically significant sign leaving us to provide further evidence on the need to explore more on other tax revenue categories to gain a clear understanding of its possible impact on economic activities. Hence, identifying the significant components even within the sub category of this revenue category would help policy makers to formulate effective taxation policies with the view of promoting faster growth and enhancing public revenue in the long term.

Moreover, in the case of other variables which have been included in this study, particularly human capital which has been included in the base line regression model, carry positive signs albeit statistically insignificant. However, despite the coefficient

sign on this variable indicating a positive impact on output growth, further evidence needs to be captured so as to gain a clear cut understanding of the possible impact of human capital in a more disaggregated manner. Furthermore, the study found that the "physical capital" has a positive effects on growth. This could be driven by the emerging importance of investment in the case of the Sri Lankan economy in achieving its long term growth target. However, it is important to examine whether investment has been affected by the changes in the composition of tax revenue which is beyond the scope of this study. This would give important insights to policy makers in formulating and designing the taxation policies in future.

The results of Granger causality tests are presented in appendix table 6 using a joint F-test approach. The analysis considered the sub-components of tax revenue. The findings indicate the existence of unidirectional causality running from income taxes, VAT and international taxes to growth. It is also found that excise taxation and other taxes are caused by output growth. This finding provides further evidence on how the tax categories are associated with long term output growth.

In summary, the results indicate that investment plays a key role in promoting long term output growth in Sri Lanka. Further, from the taxation perspective, the findings of this study suggest that not only income taxes but other tax categories also matter for output growth. In particular, one of the important long term determinants of Sri Lanka's economic growth has been income taxation, VAT and taxation other than consumption and international trade taxes. Hence, in order to minimise the possible negative impact of taxation, the distortion from taxes should be kept to a minimum level in fiscal adjustment strategies by shifting the burden of taxation from income, and international trade to domestic consumption. Further, it is also recommended to broaden the tax bases which would further enhance the tax revenue in the economy given the low level of public revenue in financing increasing government expenditure.

6. Summary and Conclusion

This study explored the differential impact of revenue-neutral tax structure on long term output growth within the framework of an endogenous growth model developed by Barro (1991) in Sri Lanka during the post liberalisation period. In order to assess the response of output growth to increasing public revenue, this study considered five major components of tax revenue namely income taxation, import taxation, VAT (domestic sales tax), excise duties, and other taxation. The results of the unit root test showed that all the variables are non-stationery at levels but all are stationery at first differences. The empirical results of the Johanson cointegration test also found a possible long term relationship between taxation and output growth. The findings show

that higher level of income taxes, import taxes and other taxes have had negative and significant impact on output growth. Contrary to this, higher level of domestic consumption tax (VAT) shows a significant positive impact on long term output growth while excise taxes do not have any impact. Analysis also indicates unidirectional causality running from income taxes, VAT and international taxes to growth. It was also found that excise taxes and other taxes are caused by output growth. These findings suggest that policy makers need to focus on the sub-categories of public revenue rather than on aggregate revenue[18].

Therefore, as far as taxation is concern, the findings of this study suggests that the government should increase its taxation on domestic goods and services while reducing income taxes, import taxes and taxes on other sectors aiming at enhancing growth. The results of this study provide a note of concern for policy makers who might believe that the tax system could create distortions in the economy. Thus, based on the evidence, the policy challenge is twofold. First, policy makers could use the results of this study as a rationale to seek tax policies that would mitigate the adverse effects of taxes on growth. Second, as the effects of taxation differ across types of taxes, the government must make further attempts to identify taxes which generate a very low level of revenue but have a very harmful impact on growth. Hence, the results appear to indicate that shifting tax revenue towards consumption taxes would provide a higher level of output growth in the long term. In addition, it is also important to create supportive legal and institutional mechanisms, infrastructure and stable macroeconomic environment which would further facilitate stimulating private sector investment to attain faster growth targets in the long term.

In summary, the study shows that various types of taxation have different degrees of impacts on output growth, implying the existence of significant potential to improve "growth generating efficiency" of taxation. Thus, it cannot simply be suggested that taxation has a negative impact on growth. Rather the findings suggest the existence of greater potential to improve the efficiency of tax revenue in order to promote growth. At the same time, while the study found useful insights on the impact of investment on output growth, it also stresses the need to examine the potential implications arising from different taxation and the nexus between taxation and investment which is beyond the scope this study. However, in order to enhance growth, it is vital to control the possible distortionary effects of taxation on investment.

[18] This result is clearly due to the positive and negative impacts of different types of taxation canceling out when the aggregate is considered.

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Appendix

Appendix Table 1: Key Description to Variables

Variables	Description
T	Time
EG	Annual economic growth rate
TREV	Total Revenue as a share of GDP
PPG	Population growth
S.E	Standard Error
PC	Investment as a share of GDP
IMT	Import Tax as a share of Total Tax revenue
VAT	Value Added Tax as a share of Total Tax revenue
INT	Income Tax as a share of Total Tax revenue
EXT	Excise Tax as a share of Total Tax revenue
OTT	Other tax revenue as a share of Total Tax revenue
HC	Education expenditure as a percentage of GDP
M2b	M2b as a percentage of GDP
INV	Investment as a percentage of GDP
TTR	Total Tax revenue as a percentage of GDP

Appendix Table 2: Results of VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-651.851	NA	124695.5	40.112	40.565	40.265
1	-405.152	328.932	22.3625	31.221	36.209	32.899
2	-189.463	156.864*	0.1563*	24.209*	33.733*	27.414*

Note: * indicates lag order selected by the criterion at 5 per cent level of significance.

Appendix Table 3: Summary Statistics of Key Variables

	Obs	Mean	Median	Std.Dev.	Min	Max
HC	34	2.468	2.488	0.377	1.750	3.230
EG	34	5.138	5.450	1.933	-1.500	8.300
M2b	34	31.483	31.945	1.873	28.138	35.264
PPG	34	1.030	1.140	0.884	-2.590	2.350
INV	34	25.944	25.650	3.031	21.200	33.800
TTR	34	15.629	15.509	2.276	11.596	19.473
EXT	34	17.286	16.672	4.627	8.521	24.923
IMT	34	18.753	18.933	7.150	8.263	31.467
INT	34	16.529	16.382	2.740	10.834	22.548
OTT	34	18.237	18.801	8.144	4.237	34.097
VAT	34	26.935	24.701	10.719	8.236	48.041

Appendix Table 4: Long Run Cointegration Equation

	Coefficients	**T - Value**
Intercept	-7.889	1.507
Human Capital	2.296**	2.245
M2b	0.149	1.082
Population Growth	3.597***	7.095
Physical Capital	0.322***	4.402
Total Revenue	0.276	1.447
Dependent Variable: Economic Growth		

Note: *, **, and *** imply the rejection of the null hypothesis at significance level of 10%, 5% and 1% respectively.

Appendix Table 5: Vector Error Correction (VECM) Estimates

Error Correction	D(EG)	D(EG)	D(EG)	D(EG)	D(EG)	D(EG)
Error Term	-0.4639**	0.3491	-0.5546	-0.2619	0.1274	-0.0820
	[-1.9803]	[0.9425]	[-1.5846]	[-1.0575]	[0.2169]	[-1.7955]
D (EG (-1))	-0.6084	-0.7039	0.3669	0.1719	-0.3536	-0.1604
	[-1.4162]	[-1.0092]	[0.8462]	[0.4316]	[-0.7093]	[-0.4795]
D (EG (-2))	-0.2164	-0.2510	-0.0600	0.1665	-0.0744	0.0573
	[-0.7766]	[-0.5139]	[-0.2224]	[0.6016]	[-0.2449]	[0.2410]
D (EDU(-1))	0.8254	9.9730	2.5271	1.2194	2.0726	2.9520**
	[0.5388]	[1.1731]	[1.6829]	[0.7713]	[1.1208]	[2.0065]
D(EDU(-2))	-1.7175	1.7975	-1.3637	-1.3913	-0.9539	-0.2736
	[-1.1301]	[0.4415]	[-0.9192]	[-0.9117]	[-0.5172]	[-0.1931]
D(INV(-1))	-0.2124	-0.7009	-0.0008	-0.4103	-0.2253	0.0225
	[-0.6501]	[-1.4341]	[-0.0018]	[-1.2516]	[-0.4723]	[0.0634]
D(INV(-2))	-0.3284	-0.0949	0.1100	-0.4357	-0.2886	-0.0907
	[-1.3208]	[-0.2759]	[0.3708]	[-1.6318]	[-1.0069]	[-0.4194]
D(M2b (-1))	0.3463	-0.0918	-0.1585	0.5829	0.3742	-0.0019
	[1.0666]	[-0.1638]	[-0.3930]	[1.6855]	[0.8338]	[-0.0057]
D(M2b (-2))	-0.0455	-0.4504	-0.1215	-0.1644	-0.0686	-0.0458
	[-0.1245]	[-0.8085]	[-0.3314]	[-0.4367]	[-0.1342]	[-0.1433]
D(POP(-1))	0.9658	0.3732	-0.8858	0.8897	-0.4185	0.3093
	[0.9431]	[0.3876]	[-1.3142]	[0.6784]	[-0.4282]	[0.5437]
D(POP(-2))	0.8835	1.4174	0.3221	0.7532	0.17251	-0.3106
	[1.0449]	[0.9131]	[0.4266]	[0.7512]	[0.1656]	[-0.5228]
D(TTR(-1))	0.8565**	0.1164	0.1539	0.2796	0.4848	0.2087
	[2.0795]	[0.1730]	[0.3594]	[0.6635]	[1.0376]	[0.5705]
D(TTR(-2))	-0.5653	-1.2319	-1.14582**	-0.0784	-0.6205	-0.4947
	[-1.1663]	[-1.5001]	[-2.1519]	[-0.1401]	[-1.0529]	[-1.2206]
D(IMD (-1))		-1.0189				
		[-1.1469]				
D(IMD (-2))		-0.1189				
		[-0.2847]				
D(INCMT(-1))			0.1751			
			[0.6965]			

D(INCMT(-2))			-0.3616			
			[-1.6402]			
D(OTT(-1))				0.2641**		
				[2.1999]		
D(OTT(-2))				-0.1061		
				[-1.0227]		
D(VAT(-1))					-0.0494	
					[-0.6184]	
D(VAT(-2))					-0.0401	
					[-0.4554]	
D(EXT (-1))						-0.3754**
						[-2.2382]
D(EXT (-2))						0.2579
						[1.2676]
C	0.1272		-0.1357	0.1001	-0.0382	0.1215]
	[0.3061]		[-0.34518]	[0.2315]	[-0.0780]	[0.3517]
R-squared	0.5918		0.6687	0.6435	0.5410	0.7542

Note: *, **, and *** imply the rejection of the null hypothesis at significance level of 10%, 5% and 1% respectively.

Appendix Table 6: Pair wise Granger Causality Tests

Null Hypothesis	Obs	F- Stat	Prob
HC does not Granger Cause EG	34	2.6814	0.0866
EG does not Granger Cause HC		0.9719	0.3916
TTR does not Granger Cause EG	34	2.6817	0.0866
EG does not Granger Cause TTR		0.1758	0.8397
EXT does not Granger Cause EG	34	0.3983	0.6753
EG does not Granger Cause EXT		3.9327	0.0317
OTT does not Granger Cause EG	34	2.0146	0.1529
EG does not Granger Cause OTT		3.2410	0.0548
INCM does not Granger Cause EG	34	1.2353	0.3067
EG does not Granger Cause INCM		4.1961	0.0259
IMD does not Granger Cause EG	34	6.5041	0.0049
EG does not Granger Cause IMD		0.3175	0.7306
VAT does not Granger Cause INV	34	1.0845	0.3523
INV does not Granger Cause VAT		2.5836	0.0940
OTT does not Granger Cause INV	34	0.2053	0.8156
INV does not Granger Cause OTT		2.5568	0.0962
VAT does not Granger Cause INV	34	1.0845	0.3523
INV does not Granger Cause VAT		2.5836	0.0940
INCMT does not Granger Cause INV	34	1.3175	0.3317
INV does not Granger Cause INCMT		2.4131	0.1215

Note: The number of lag that has been selected in the granger causality test is 2

Carry Trades and Tail Risk of Exchange Rates

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Abstract

Historically, Carry trades have been a success story for most investors and a major source of funds for emerging economies maintaining higher interest rates. Therefore it is a timely topic to investigate the risk embedded in such transactions and to what extent the carry trade returns explain the tail risk. Initially, this research estimates the tail index of all the currencies and formulates a unique inverse function for all the currencies in relation to Power laws, with the idea of estimating the respective Value-at-Risk. This research considers twenty five currencies and replicates them in to five portfolios based on the annualised daily return of a weekly forward contract. Trade was executed assuming a U.S. investor, who goes long in the high return portfolio and short in the low return portfolio. Further, this research examines the impact of carry trade returns on the overall tail risk within the context of foreign exchange and interest rate gain in long and short positions of the trade. The results indicate that tail risk cannot be explained effectively by its returns because of its exponential nature. However, this paper finds that, the tail risk is mostly influenced by the long position of the carry trade. Furthermore, the return of the foreign exchange component appears to have a better explanation on the tail risk compared to the interest rate return. The Value-at-Risk analysis also suggests that the tail risk of overall strategy is influenced by the tail risk of foreign exchange component embedded in the long position of the trade.

Key Words: *Heavy-tailedness, Carry Trade, Value-at-Risk*

JEL Classification: *F30, F37, G15*

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1. Introduction

Carry trade strategy is a popular investment strategy when it comes to Foreign Exchange trading. According to Uncovered Interest Parity (UIP), the exchange rates will eliminate the returns received from the difference of interest rate across the respective countries. A carry trade can also be fulfilled via buying a foreign currency forward when it's at a forward discount or vice versa. The main idea is to borrow the low yielding currencies and invest in the high yielding currencies, thereby earning the spread in between. Even though theoretically we assume an arbitrage free environment, reality says otherwise

Fama (1984) confirms that regression of exchange rate changes with respect to the change in interest rate yields a value less than 1, while it has to be equal to 1 according to UIP. That is, the returns on the high yielding currency does not equal the return on the low yielding currency taken with the expected appreciation of the foreign currency. Fama (1984) recognizes this flaw of UIP as the "forward premium puzzle". Despite the historical evidence of high returns, the carry trade positions will be exposed to higher risk as the volatility of the currency increases. The borrowers will try to close their debt positions against the respective lenders if the borrowing currencies start appreciating. Moreover, academic evidence indicates that carry trades often suffer large losses during insecure markets conditions, even though such trades perform well in conducive markets (Farhi *et al*. 2013, Liu *et al*. 2012).

In practice, developing countries account for higher interest rates on investments and therefore an attractive carry trade opportunity for the investors. On the other hand, investors are more concerned about the risk of the opportunity despite the attractiveness of the opportunity. In this context, the question arises whether the carry trade returns influence the respective crash risk. Further it is observable that most active carry traders are present in major emerging market currencies. Therefore if one currency crashes, there exists a high probability that it might spread to other surrounding economies. Despite the strength of the economy, the regulators of financial institutions are more concerned with the extreme events which might force the liquidation of the financial institution leading to an imbalance in the financial system. Therefore, this paper intends to focus this research specifically on tail risk which is frequently used by regulators in order to access the funding limits of the investors. Moreover, should the investors be concerned about the tail risk at all when they invest in high interest rate currencies?

The most trivial way to estimate tail risk is to assume that returns are normally distributed. However, due to the inefficiency of this assumption, later studies[2] utilised more heavy tailed distributions such as student-t. Both these methods are most likely to either

2 Please refer to Kole and Verbeek (2006).

underestimate or overestimate the tail risk as it does not recognise the tail of the actual distribution. Further, the financial markets have been vulnerable to extreme fluctuations in asset prices, especially during the recent global financial crisis, which gave rise to the need of effective methods that capture extreme losses. Therefore this study applies the power law distribution[3] in order to estimate the thickness of the left tail of each return distribution in view of obtaining a unique estimate for each return distribution, which will allow the investment managers/risk managers to observe the possibilities of extreme losses.

This paper observes the significant effects of tail risk embedded in the carry trades of exchange rates. Findings of this research will provide evidence as to whether the regulators should account for tail risk in order to access the firm's risk on foreign currency exposure. Previous research by Menkhoff *et al*. (2012a) analyse the crash risk ignoring the concern of volatility clustering in financial markets. As per the findings of Mandelbort (1963), positive changes, of financial returns tend to be followed by positive changes and negative changes tend to be followed by negative changes despite the returns being large or small. In other terms, it is the serial correlation of squared returns also known as volatility clustering. The tail risk estimates of this research, capture the volatility clustering embedded in financial returns in the cause of estimating implied volatility, which is relevant in order to protect the accuracy of the tail risk estimation. In fact, this research introduces a new methodology to estimate the tail risk of financial returns.

According to the definition of UIP that the expected change in the future spot rate is directly proportional to the change in the interest rates. Therefore the excess return of the investor in a potential carry trade is the difference between the future spot rate and the forward rate for the same period. Therefore, this research examines the tail risk of a potential High-minus-Low (HML) trading strategy where, the investors will fund the high yield investment (long position) by selling a low yield investment (short position). In line with the decomposition of the carry strategy returns into interest rate returns and foreign exchange (forex) returns, this research provides evidence as to which component of this HML strategy influences more on the tail risk of a carry trade. I critically analyse the individual and collective impact of returns from long and short positions as well as forex and interest rate components, on Value-at-Risk of the respective HML strategy, the selected representation of tail risk for the purpose of this research.

This research concludes that, the proposed method of estimating the tail risk of the carry trade strategy operates effectively when currencies are relatively volatile and therefore presents a better estimate compared to pre-determined distributions (Normal and Student-t

3 The power law distribution is applied in order to identify the probability of market crashes by Embrechts *et al.* (1997) and Ibragimov et al. (2013).

distributions). Further, the results suggest that, the forex component of the long position of the carry trade is the most influential in terms of the tail risk of the overall strategy.

This paper is organised as follows; Section 2 contains a summary of previous studies in this subject area. Section 3 explains the selection of data and construction of the methodology. Section 4 presents an analysis of the empirical results obtained in the research. The conclusion of this research is reported in section 5. Further, the methods applied in this research are presented in appendices.

2. Literature Review

Froot and Thaler (1990) explain that, there is no systematic relationship between the risk premium generated by an asset pricing model and the inconsistencies of exchange rates. Further, they claim that the bias arises only because of the expectation errors. In contrast, Bekaert (1996) claims that forward premium puzzle is explained reasonably well by the varying risk premia required to compensate for the uncertainty in the fundamentals.

Several empirical studies have explored the risks of carry trades in terms of portfolios instead of individual currencies including, Farhi and Gabaix (2013) who construct a metric called "risk reversal" (implied volatility of out-of-the-money put option minus implied volatility of out-of-the-money call option) and finds that it moves negatively with spot exchange rates. This implies when the corresponding exchange rate depreciates then the "risk reversal" increases. They further claim that, the correlation between interest rate and exchange rate depends more on net foreign trade and the vulnerability of the economy. These findings are consistent with Brunermeier *et al*. (2009) who claim that, inclusion of more currencies will not reduce the risk represented by skewness and kurtosis. Further, they find that, carry trades deliver negatively skewed returns and further the currency crashes increase the implied stock market volatility due to unexpected withdrawal of investments in high interest currencies. These findings were supported by Christiansen *et al*. (2011), who further explain that carry trade returns are related to volatility and liquidity of the equities. Extending the research of Brunermeier *et al*. (2009), Ferreira *et al*. (2013) examine the impact of funding risk on carry trade and therefore confirm that increased funding risks may contribute to high volatility of investment currency.

Menkhoff *et al*. (2012a) discover that high yielding currencies are exposed to global forex volatility where, low yielding currencies hedge against the volatility. They also find that liquidity risk also has a reasonable impact on currency returns. This supports the earlier findings of Burnside *et al*. (2011) where they state that high volatility could be related to currency crashes when there are liquidity constraints. However, Barro and Ursua (2011) claim that, even though one-third of carry trade returns are from the crash-risk premium

during the pre-crisis analysis, carry trade return do not even compensate for the crash-risk premium when the carry trade portfolios are extended till the year 2008. Relating these findings to their paper, Farhi and Gabaix (2013), and Farhi *et al*. (2013) confirm that, high yielding currencies tend to depreciate in bad times while low yielding currencies tend to appreciate. Furthermore they find that the compensation requirement for crash risk after the global financial crisis is greater than it was before the crisis.

Menkhoff *et al*. (2012b) show that forex returns generated based on momentum strategies are not stimulated by policy regimes. However they further state that carry trade returns are mostly compensation, for the risk embedded in long positions of the trade. Lustig and Verdelhan (2007) claim that a larger portion of average exchange rate fluctuations are explained by the risk inherited in consumption growth patterns. Moreover, according to Lettau *et al*. (2002) the direct effects of higher interest rates on consumption are important in terms of the monetary policy of a country. These finding are consistent with Jylha *et al*. (2008), where they alarm the regulators as they provide evidence for carry trades to complicate the monetary policy implementation of individual countries and therefore the economies will be exposed to substantial interest and currency rate fluctuations. Therefore, the monetary aggregates of the countries in long positions of carry trades are expected to be more volatile compared to countries in short positions.

Even though there is a reasonable amount of research done on volatility as a measure of risk, research explicitly focusing on the tail risk of carry trades, is limited. Burnside *et al*. (2011) state that carry trade portfolio payoffs are uncorrelated with the regular risk factors. They further argue that the returns that are generated could be related to the tail risks which are mentioned as "peso events". Berge *et al*. (2010) provide evidence for the argument of Burnside *et al*. (2011), where they explain the carry trade profits perceived before the global financial crisis, merely compensate for the tail risk. Dupuy (2013) utilizes Value-at-Risk (VaR) as the measure of risk instead of the volatility risk premia and finds that it is more effective in determining the funding limits set for the investors by the regulators. Brunermeier *et al*. (2009) provide evidence that highlights the importance of such limits and reasons out events leading to crash risk. They claim that when the VaR limits are violated due to the fluctuations, the regulators will be forced to close their positions. Therefore this undue selling pressure with possible overreaction may cause the carry trade currency to depreciate sharply.

3. Data & Research Methodology

3.1 Data

This research takes in to consideration 25 different currencies which are a mixture of developed and emerging economies that cover different regions around the world where, DataStream is the only data source. Relevant daily spot and 1 week forward rates are obtained from 29/03/2004 till 09/05/2014, keeping the U.S. Dollar (USD) as the base currency. The selected period consists of a global financial crisis, which would reflect the behaviour of each currency during such times. Moreover, Menkhoff *et al*. (2012a) state that, the carry trades returns decrease significantly during financial turmoil, while they are highly rewarding in a healthy financial environment. Therefore it is essential to ensure that the selected period of time includes both negative and positive market sentiments, in order to capture the respective extreme movements of carry trade returns. The currencies selected are as follows: Argentine Peso (ARS), Australian Dollar (AUD), Brazilian Real (BRL), Canadian Dollar (CAD), Chilean Peso (CLP), Chinese Yuan (CNY), Czech Koruna (CZK), Euro (EUR), Sterling Pound (GBP), Hong Kong Dollar (HKD), Hungarian Forint (HUF), New Israeli Shekel (ILS), Indian Rupee (INR), Japanese Yen (JPY), South Korean Won (KRW), Mexican Peso (MXN), New Zealand Dollar (NZD), Philippine Peso (PHP), Polish Zloty (PLN), Russian Rouble (RUB), Singapore Dollar (SGD), Thai Baht (THB), Turkish Lira (TRY), New Taiwan Dollar (TWD), South African Rand (ZAR).

3.2 Methodology

3.2.1 Estimating the Tail index

According to Mandelbort (1963), asset returns produce distributions of which the second moments are infinite, which deviate from the Gaussian distributions. He challenged the Gaussian assumptions by emphasizing the difference of financial returns distributions with the help of power laws. Supporting Mandelbort (1963), Fama (1963) finds that the empirical distribution of every stock out of thirty stocks examined, had heavier tails compared to a normal distribution. According to Embrechts *et al*. (1997), the returns of financial markets deviate from the Gaussian distributions and therefore there exists an excess kurtosis. Ibragimov *et al*. (2013), in their assessment of tail index use the power law distributions to represent the probability mass in the tails of exchange rate distributions such that,

$$\Pr(|r| > x) \sim \frac{C}{x^{\zeta}} \quad --(1)$$

where, r is the variable of interest and ζ is the tail index of the returns distribution and C is the normalization constant. There are mainly two methods to estimate the tail index of a returns distribution namely, log-log-rank-size method and the hills estimator (Hill 1975). However, Ibragimov *et al*. (2013) state the drawback of Hill's estimator such as sensitivity to dependence and small sample sizes, and hence this study uses log-log rank size to determine the tail index along with the adjustment proposed by Gabaix and Ibragimov (2011). This method is explained in Appendix A.

3.2.2 Generating the tail risk measure

Even though the VaR method is believed to be the most appropriate to estimate the crash risk of financial returns (Ibragimov *et al*. 2013, Dupuy 2013), the same method has been criticized by many researchers such as, Beder (1995), who claims that, VaR changes with the selection of the certainty. Further, VaR provides an expectation of outcomes sheltered by a specific set of assumptions, rather than the confidence of outcomes. Moreover, VaR was found non-sub additive when return distributions are extremely heavy tailed (Artzner *et al*. 1999). However it's discovered that sub additive property of VaR holds, whenever the tail index is greater than 1(*i.e*., ζ>1)(Daníelsson *et al*. 2013). This implies the VaR of a currency portfolio will remain lower than the aggregate risk of those currencies taken individually.

According to Table 1, it is observed that, the currencies of developed countries such as United Kingdom, Australia, Canada exhibit a higher tail index, while the currencies of emerging economies are relatively heavy tailed (lower tail index). However, none of the tail indices of selected currencies are less than 1. Therefore it is appropriate to use the VaR as our risk measure as the sub-additive property holds during the intended analysis which is very important in terms of the currency portfolios that I create later in the next section. According to Christoffersen (2012), VaR for a normal distribution is defined as follows,

$$VaR_{t+1}^{p} = \sigma_{t+1} * \phi^{-1}(P) \quad --(2)$$

Christoffersen and Gonclaves (2004) apply GARCH(1,1) to calculate the volatility and an EVT approach to find the respective quantile in a Generalized Pareto distribution along with the Hill's estimator (Hill 1975) in order to account for volatility clustering and heavy tails in financial returns respectively. The evidence provided by Nozari *et al*. (2010) support the method of Christoffersen and Gonclaves (2004), where it overcame the capability of Student-t and Normal distributions. Further considering the fact that Generalized Pareto distribution is a special case of power laws and the tail index estimation is based on

Table 1: Tail Index Estimation

Currency	Tail Index	Constant	SE	t-Statistic
ARS	1.3820	-10.4725	0.0087	-159.25
AUD	3.0591	-16.6051	0.0104	-293.39
BRL	2.3612	-13.1287	0.0096	-246.19
CAD	2.9981	-17.2755	0.0156	-192.06
CLP	3.0692	-17.3174	0.0286	-107.18
CNY	2.2545	-18.0796	0.0233	-96.68
CZK	3.1484	-16.9311	0.0166	-189.13
EUR	3.3529	-18.4859	0.0209	-160.11
GBP	3.1039	-17.6705	0.0172	-180.05
HKD	1.7442	-16.7472	0.0091	-191.09
HUF	3.1228	-16.3700	0.0159	-196.17
IDR	1.8553	-11.6198	0.0149	-124.13
ILS	2.8990	-17.2581	0.0292	-99.13
INR	2.2218	-14.5987	0.0245	-90.52
JPY	2.8692	-16.1926	0.0180	-159.84
KRW	2.1743	-13.5067	0.0075	-288.84
MXN	2.5744	-15.2736	0.0094	-273.42
MYR	1.9272	-13.3888	0.0240	-80.16
NZD	3.2442	-17.1961	0.0183	-177.44
PHP	2.6574	-16.8542	0.0305	-87.01
PLN	2.9260	-15.6626	0.0176	-166.23
RUB	2.1912	-13.9642	0.0185	-118.20
SGD	2.7245	-17.5486	0.0080	-341.16
THB	2.2314	-14.5253	0.0122	-182.24
TRY	2.3992	-13.6479	0.0067	-356.76
TWD	2.4656	-16.8004	0.0220	-112.13
ZAR	3.0047	-15.5601	0.0244	-123.33

Note: This table presents a summary of the tail index estimation by way of following the log-log-rank-size (Appendix A) method with a truncation of 10%. The Tail index column is self-explanatory whereas the third column is the intercept generated upon regression. Further SE is the standard error of the tail index followed by the corresponding t-Statistic.

power laws, it makes more sense to derive the cumulative density function (cdf), using the original probability density function (pdf) of power law distribution. Therefore, this research introduces the parameter *Zp*, which is the derived (1-p) th quantile of the power law distribution, given a probability of p that returns fall below the threshold. The proposed

methodology to derive parameter *Zp* is demonstrated in Appendix B. Christoffersen & Gonçalves (2004) introduces a similar method to find the cdf of the distribution starting from Generalised Pareto distribution. However, this research uses the original probability density function of power laws as the starting point and derive the respective cumulative density function. Consequently, the VaR model used for this research is as follows,

$$VaR_{t+1}^{p} = \sigma_{t+1} * Z_p \quad --(3)$$

According to the equation, it is obvious that either an increase in volatility and/or a decrease in the tail index (fatter tail) will lead to higher tail risk. As per the findings of Mandelbort (1963), positive changes of financial returns tend to be followed by positive changes and negative changes tend to be followed by negative changes, despite the returns are large or small in other terms it's the serial correlation of squared returns. Bollerslev (1986) developed the Generalized Autoregressive Conditional Heteroskedasticity(GARCH) model in order to capture the serial correlation between squared returns and later GARCH(1,1), the simplest version of the GARCH model which was used by Orlowski (2010) in order to find the conditional volatility of exchange rates that accounts for tail risk. This research uses the following GARCH(1,1) model, in order to capture volatility clustering.

$$\sigma_t^2 = \omega + \alpha R_{t-1}^2 + \beta \sigma_{t-1}^2 \quad --(4)$$

In order to start the process, the unconditional expectation of σ_t^2 is considered to be σ_t^0 . The parameters ω,α,β will be estimated such that, the log Likelihood of the function is maximized. According to Hansen and Lee (1994) the Gaussian likelihood function is consistent in estimating the parameters for GARCH(1,1), even if the variable is non-Gaussian. Therefore the likelihood function is as follows,

$$L_n(\theta) = -\frac{1}{2}\sum_{t=1}^{n}[\ln(\sigma_t^2(\theta)) + \frac{R_t^2}{\sigma_t^2(\theta)}] \quad --(5)$$

3.2.3 Portfolio construction

This research intends to create five carry trade portfolios for the selected currencies, keeping the USD as the base currency. This implies an investor in the United States, who borrows at spot rate S_t at time *t* and settles the loan on a date after one week. If the assumption on the expectation hypothesis holds good, then the forward rate today F_t is

equal to the expected spot rate after one week. Therefore I can write the excess return at time *t* as;

$$r_t = \frac{(S_{t+5} - F_{t,t+5})}{S_t} \quad --(6)$$

This research assumes an investor who executes a carry trade each week consisting of 5 business days and he rolls over to a similar contract upon the maturity of the existing contract. Unlike most of the research available, this method provides a solution for the existence of high serial correlation that is induced by calculating daily return on a one week contract instead of using a rolling window. The following equation explains the decomposition of excess returns at time t (Further explanation is given in Appendix C).

$$\frac{(S_{t+5} - F_{t,t+5})}{S_t} = \frac{(S_{t+5} - S_{t+4})}{S_t} + \frac{(S_{t+4} - S_{t+3})}{S_t} + \cdots + \frac{(S_{t+2} - S_{t+1})}{S_t} + \frac{(S_{t+1} - F_{t,t+5})}{S_t} \quad --(7)$$

Further decomposition of the above equation will segregate the excess returns in to two components, *i.e.,* the forex component and the interest rate component. The detailed explanation is given in Appendix C.

Once the returns are decomposed, the research intends to find the tail risk in each components individually. Further, it is more constructive to focus our research on a particular trading strategy for a portfolio of currencies, rather than emphasizing on each currency. Therefore, this research implements a HML strategy, as it replicates the true form of a carry trade. The proposed HML strategy goes long in portfolio of high returns, while going short in portfolio of low returns. Conforming to the above argument, five portfolios are created, namely P1, P2, P3, P4 and P5, which are in ascending order according to the average returns, where P1 contains the currencies that produce highest average returns and currencies in P5 are the lowest of all five portfolios.

3.2.4 Evaluating tail risk

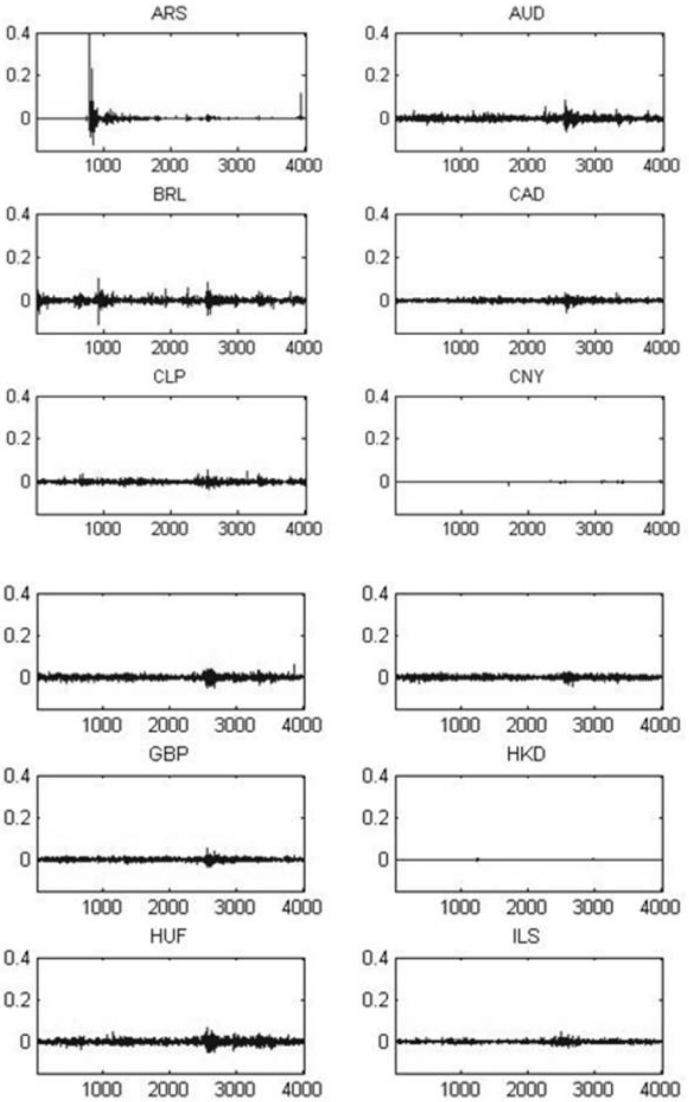
A recent study by Menkhoff *et al*. (2012a) estimate the Fama-MacBeth regression (Fama and MacBeth, 1973) which is based on the Capital Asset Pricing model (CAPM) in order to find the risk premium relevant for the excess return of a Carry trade strategy. However, the main goal of our research is to access the impact of a carry strategy return on VaR of the overall strategy, which is more inclined towards the perception of a risk manager.

Therefore we consider VaR as the dependent variable of this analysis and it is regressed on returns of the overall strategy, long and short portfolio returns and, forex and interest rate components of the strategy. Autocorrelation may still exist in returns as we observe in most financial returns data. Therefore, an Ordinary Least Square (OLS) estimator can be insufficient to estimate the respective relationship between VaR and returns. Feasible Generalised Least Square (FGLS) estimator is considered to be the popular alternative in terms of tackling the inherent Heteroskedasticity and Autocorrelation, which makes the Gauss-Markov assumptions invalid (Hansen, 2007). However, according to Fomby *et al*. (2012), the FGLS may not be the most appropriate estimator, as the sample is relatively smaller and standard errors are substantially higher. Accordingly, the Heteroskedasticity and Autocorrelation Consistent (HAC) estimator introduced by Newey and West (1987), which accommodates relatively smaller samples, is used.

4. Empirical Results

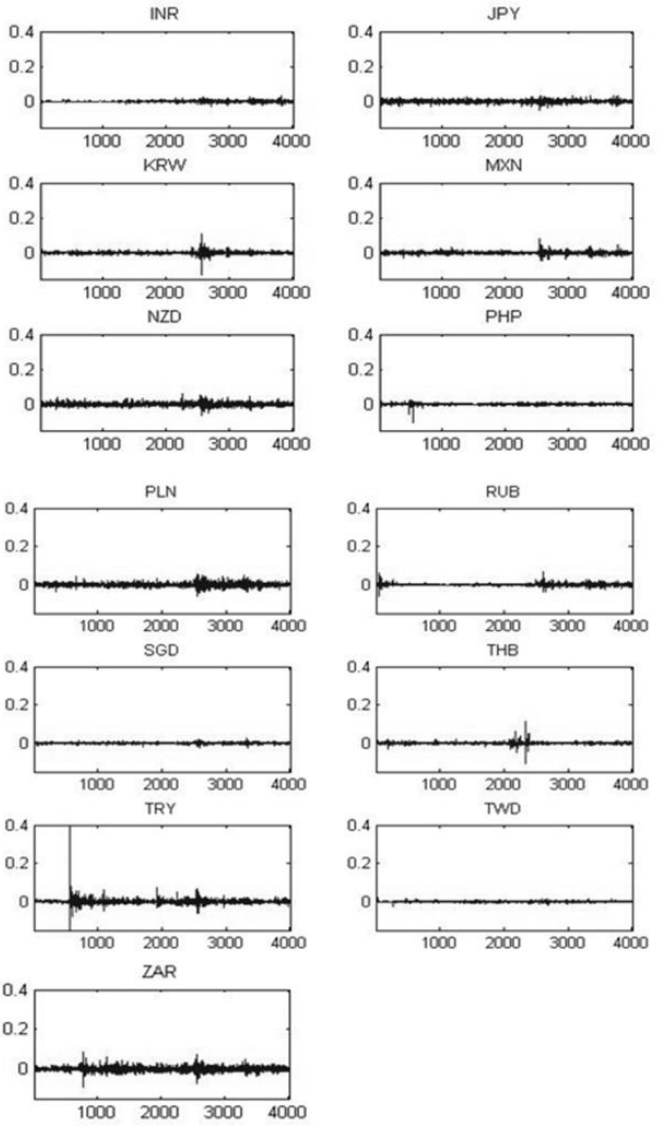
Figure 1 represents the exchange rate return of each currency under consideration, in order to determine their nature. It is observable that, there are signs of volatility clustering in almost every currency that is under examination. Further it's evident that emerging economy currencies such as, Argentine Peso (ARS), Brazilian Real (BRL), South African Rand (ZAR), Polish Zloty (PLN) and Turkish Lira (TRY) exhibit higher levels of volatility clustering. Moreover, historical data indicates that there had been some extreme fluctuations in ARS and TRY in both positive and negative directions. However, it is seen that developed market currencies such as GBP and EUR are more volatility clustered than some of the emerging market currencies such as Chinese Yuan (CNY) and New Taiwan Dollar (TWD) as a result of pegged exchange rates in order to keep the production costs low. However, pegged exchange rates policy of a country has to be supported continuously by its reserves. There could be large depreciations if countries run out of reserves to defend the exchange rate and therefore large fluctuations (Thai Baht crisis in 1996-1997). A further look in to the tail index of each currency presented in table 1 justifies the findings of Ibragimov *et al*. (2013), which conclude that, the exchange rates of developing economies are heavier tailed than the developed economies and they are differently heavy-tailed among each other. However this argument may not be entirely acceptable with respect to some of the emerging market currencies. Out of the emerging economies, Chile (CLP), Hungary (HUF) and South Africa (ZAR) have a tail index, which is estimated to be 3.0692, 3.1228 and 3.0047, respectively. This is much greater than that of developed countries such as Japan (JPY) and Canada (CAD). Further, the results indicate that, the tail index of CNY and Hong Kong Dollar (HKD) is surprisingly low despite their achievements in the past.

Figure 1: Currency returns over time



Note: The graphs exhibit the returns of all currencies across time. The vertical axis represents the daily return, while the horizontal axis represents time in days. The sample period runs from March 1998 to June 2014 where the exchange rates are from DataStream.

Figure 1: Currency returns over time continued.



Note: The graphs exhibit the returns of all currencies across time. The vertical axis represents the daily return, while the horizontal axis represents time in days. The sample period runs from March 1998 to June 2014 where the exchange rates are from DataStream.

Table 2 indicates the average VaR calculated using power law, Normal and Student *t* distribution for each currency. The most significant observation is the VaR of ARS, which is estimated to be 10.92% using the Power law distribution. However the same estimation based on the assumption of either Normal or Student *t* distributed returns, is found to be significantly low. According to the behaviour of the respective inverse function, it is sensitive to extreme historical losses and therefore ARS has a very high quantile due to its maximum historical daily loss (X_{min}) of 12.50% along with its high volatility. However despite having a low tail index, HKD appears to have a lower VaR compared to TRY which has a tail index estimated to be much higher. Further, currencies such as GBP, EUR and AUD have a higher tail index compared to CNY, their VaR is estimated to

Table 2: $VaR_{1\%}$ Estimation

Currency	Tail Index	Max Loss/ Per day %	Average Implied Volatility	VaR (Power Law) %	VaR (Normal) %	VaR (Student-t) 3 df %
ARS	1.3820	12.50	0.0131	-10.92	-2.02	-2.27
AUD	3.0591	6.05	0.0067	-1.40	-1.77	-1.99
BRL	2.3612	11.11	0.0118	-5.49	-2.12	-2.39
CAD	2.9981	5.56	0.0031	-0.92	-1.21	-1.36
CLP	3.0692	3.73	0.0042	-0.68	-1.40	-1.58
CNY	2.2545	2.01	0.0001	-0.09	-0.18	-0.21
CZK	3.1484	5.07	0.0060	-1.10	-1.73	-1.94
EUR	3.3529	4.16	0.0039	-0.68	-1.42	-1.60
GBP	3.1039	3.79	0.0033	-0.62	-1.27	-1.43
HKD	1.7442	0.67	0.0000	-0.06	-0.11	-0.12
HUF	3.1228	5.07	0.0083	-1.28	-2.00	-2.25
ILS	2.8990	2.83	0.0024	-0.43	-1.04	-1.17
INR	2.2218	3.02	0.0016	-0.67	-0.79	-0.89
JPY	2.8692	4.81	0.0043	-1.06	-1.50	-1.68
KRW	2.1743	12.42	0.0044	-4.70	-1.24	-1.40
MXN	2.5744	4.65	0.0044	-1.17	-1.36	-1.53
NZD	3.2442	6.14	0.0071	-1.39	-1.89	-2.13
PHP	2.6574	10.50	0.0018	-1.54	-0.85	-0.96
PLN	2.9260	5.89	0.0083	-1.64	-1.96	-2.21
RUB	2.1912	5.82	0.0029	-1.67	-0.97	-1.09
SGD	2.7245	2.55	0.0011	-0.30	-0.73	-0.82
THB	2.2314	10.45	0.0027	-2.66	-0.91	-1.03
TRY	2.3992	15.00	0.0153	-8.93	-2.68	-3.01
TWD	2.4656	2.59	0.0007	-0.30	-0.56	-0.63
ZAR	3.0047	9.14	0.0115	-2.86	-2.31	-2.60

Note: This table presents a summary of the VaR in columns five, six and seven, with power law, normal and student-t distributions respectively. VaR is estimated at 1% probability and 3 degrees of freedom in the case of student-t distribution. Further, third and fourth column represents the Maximum % loss per day and the average daily implied volatility. Tail index is estimated using the log-log-rank-size method demonstrated in Appendix A.

be greater than that of CNY. This behaviour is due to the low implied volatility of the currency especially when it comes to HKD and CNY. They exhibit characteristics of a currency that has been pegged with negligible percentage of daily volatility over the years. The method that is introduced in this research provides evidence of a good VaR estimate whenever the tail index is relatively lower or when there has been an occurrence of an extreme lost in the past. Further, the VaR estimation method proves to be very sensitive when the tail index is extremely low (ex: ARG-1.382) and similarly it estimates a lower VaR compared to Normal and student-t distributions, when it comes to currencies with higher tail indices. According to Brunnermeier *et al.*(2009), the illiquid currencies are more vulnerable for currency crashes. Therefore a lower estimate of VaR need not be an underestimate considering the fact that some of the popular denominations such as GBP, EUR and JPY are widely held among investors and therefore more liquid relative to other currencies, which diminishes the probability of currency crashes.

Accordingly, the proposed VaR estimation methodology is proven to yield an accurate estimate in comparison with normal and student-t distributed return assumptions. Therefore the same estimation methodology will be applied to determine the VaR of the carry trade returns throughout this research.

4.1 Impact of tail risk on the overall HML carry trade strategy

After forming five portfolios in table 3, two HML strategies were formed, namely, P1 minus P5 (P1-P5) and P2 minus P5 (P2-P5). The former strategy produces the highest carry trade return, while the latter strategy is the best alternative in terms of returns. Returns generated were regressed on the tail risk of the HML strategy. The residuals retrieved through the OLS estimation suggest the presence of Heteroskedasticity and Autocorrelation. Which implies that the independent variable(s) and the error terms are correlated and the true variance is underestimated. Such concerns will force the rejection of the null hypothesis, even though it is true. Therefore this research uses the alternative of HAC estimator in order to estimate the regression.

According to table 4, both strategies, P1-P5 and P2-P5, obey the risk return fundamentals as the coefficients remain positive in both instances while the average return is positive. P1-P5 seems to have a better explanation for its tail risk with relatively larger adjusted R-square compared $(\overline{R^2})$ to a negligible $\overline{R^2}$ of P2-P5. Further, the sensitivity of returns are greater, indicating the fact that in order to realise higher gain, the investor has to account for a greater amount of risk compared to a low return carry strategy. However, the hypothesis that returns of P2-P5 strategy are not significant to explain the risk, cannot be rejected under 95% level of significance, implying that low yielding HML strategies are no longer capable of explaining the amount of risk taken. Despite its higher returns, evidence

Table 3: Currency Portfolios

$$r_t = \frac{(S_{t+5} - F_{t,t+5})}{S_t} * 100\%$$

P1		P2		P3		P4		P5	
	r_t (%)		r_t (%)		r_t (%)		r_t (%)		r_t (%)
BRL	11.62	PLN	4.633	RUB	3.124	KRW	2.079	EUR	0.937
ARS	5.714	PHP	4.517	CLP	2.876	CAD	2.013	GBP	0.116
NZD	5.574	HUF	3.963	MXN	2.643	INR	1.734	HKD	-0.40
TRY	5.553	THB	3.226	CZK	2.581	CNY	1.567	TWD	-0.99
AUD	4.860	ILS	3.222	SGD	2.131	ZAR	1.227	JPY	-1.19

Note: This table presents the formation of five currency portfolios P1, P2, P3, P4 and P5. These portfolios are formed according to the average returns (r_t) generated according to the method demonstrate in Appendix C. Returns are calculated assuming a US investor entering into a one week forward currency contract. Daily returns are calculated for the period of the contract and a new contract is formed once the current contract matures. All return figures are annualised and P1 currency portfolio earns the highest return.

of high tail risk point towards P1-P5 strategy where, it produces greater excess kurtosis and negative skewness in comparison to the P2-P5 strategy. Burnside (2009) provides skewness related evidence that carry trades are exposed to crash risk where he conclude that skewness increases as the returns form long-short strategy decrease. Moreover, the results conveyed by its moments are well supported by the tail index generated through

Table 4: Return of HML strategy Vs. Currency tail risk

$$\boldsymbol{VaR = constant + \beta\,(HML_{return}) + \varepsilon}\text{------(1)}$$

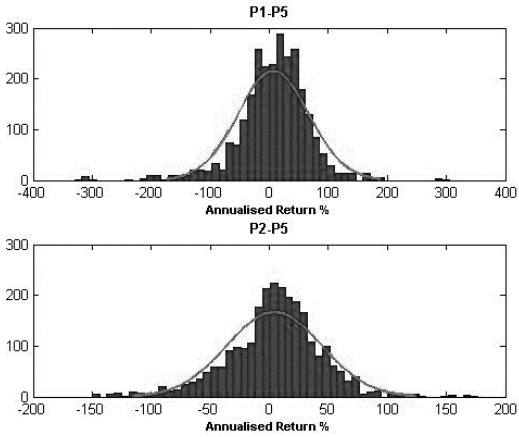
HML	Mean Return %	Average Volatility %	Kurtosis	Skew	Tail Index	Beta	t-Stat	$\overline{R^2}$ %
P1-P5	6.97	8.6894	7.4417	-0.804	1.6557	0.2960	2.486	0.96
P2-P5	4.22	5.7559	4.7986	-0.283	2.0662	0.0054	1.760	0.00

Note: This table presents the relevant statistics and regression results of the two HML strategies, P1-P5 and P2-P5, according to the regression equation (1). The mean return and average volatility are annualised. Beta column represents the coefficient of the regression output and the next column refers to the corresponding t-statistic obtained according to Newey-west standard errors.

power law distribution. In fact, the tail index of the overall carry trade strategy is less than most of the individual currencies indicating that it is more risky to hold the position on the carry strategy than most of the individual currencies.

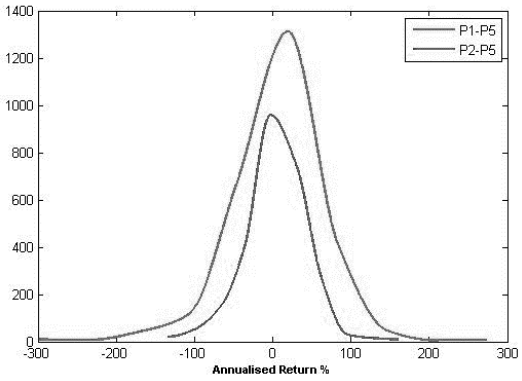
These facts are well justified by the relevant histograms as presented in figures 2 & 3 and, it is further observed that P1-P5 strategy has a heavier left tail which implies the

Figure 2: Annualized returns of Carry trade portfolios



Note: The graphs exhibit the histograms for annualised returns of two carry trade strategies, P1-P5 and P2-P5. Portfolio returns of P1, P2 and P5 are calculated based on the method described in Appendix C. Both the histograms are fitted with the relevant normal distribution.

Figure 3: Annualized returns of Carry trade portfolios

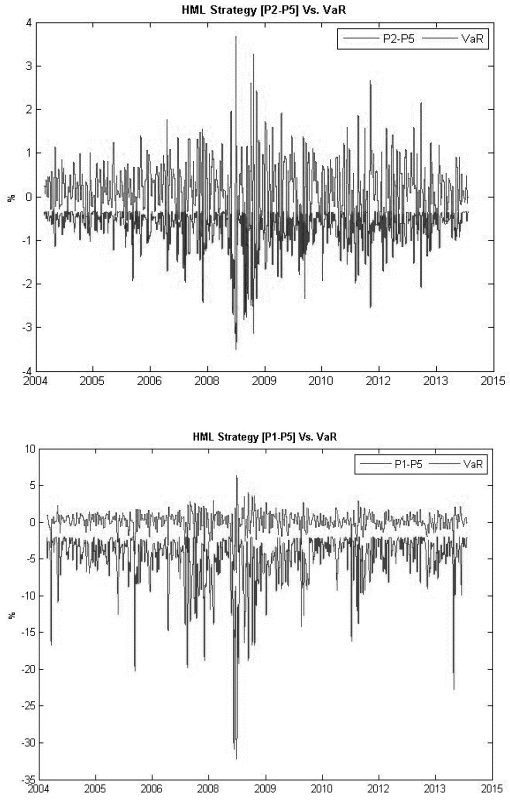


Note: The graph represents the two histograms for annualised returns of two carry trade strategies, P1-P5 and P2-P5. Marked in light is the P1-P5 strategy and P2-P5 is marked in dark.

possibility of extreme losses than P2-P5 strategy. Therefore we can mark this difference in heavy-tailedness as a representation of the premium required to compensate for additional risk accumulated on the investment.

Graphical representation of VaR of the overall strategy across time (Figure 4) implies that VaR estimated explodes to higher levels once it observes high volatility in HML strategy. Such behaviour could be experienced during the time of financial turmoil in year 2008–2009 that is applicable for both the HML strategies. However, extreme movements in VaR of P2-P5 strategy appears to be lower, compared to the P1-P5 strategy conforming

Figure 4: Value-at-Risk Vs. Daily returns of carry trades



Note: The graph represents the behaviour of Value-at-Risk (VaR) (Marked in dark) along with daily returns of strategies P1-P5 and P2-P5 over time (Marked in light). Time period runs from March 2004 to June 2014. VaR is calculated using the implied volatility of the returns generated from P1-P5 strategy and inverse function estimated as demonstrated in Appendix B.

to the difference in returns of the two strategies. A closer observation will capture the downward movement of VaR (increase in VaR) above a certain level which implies that there is a risk of holding the position tomorrow, even though both implied volatility and return today, is zero.

Therefore the proposed method of VaR estimation allows the risk management to reserve provisions in case of an unexpected market crash in the future despite today's calmness. According to Barro and Ursua (2011), the risk premium that is estimated is not sufficient to meet the crash risk after taking the period of global financial crisis in to consideration. This statement supports the results obtained with respect to the carry trade tail risk, from the fact that the explanatory power increases with the corresponding carry trade return. Therefore, more explanatory power of the regression implies better compensation for the tail risk confined. Further, it is reasonable to expect the adjusted $\overline{R^2}$ to increase when the effected economies are recovering from the crisis and decrease at the onset of a financial crisis. It is observed above that VaR increases exponentially when the tail index falls beyond a certain point, which implies that lower the tail index, higher the required return in order to compensate for the tail risk incurred.

4.2 Tail risk embedded in long and short positions of HML carry trade strategy

Having seen the impact of HML returns on the tail risk, further analysis is carried out in order to determine the influence of each long and short position of the strategy towards the overall tail risk of the strategy. The volatility of each portfolio remains uneven despite the declining returns of portfolios P1 to P5. Both kurtosis and skewness appear to follow

Table 5: The risk/return parameters of each portfolio.

	P1	P2	P3	P4	P5
Return (%)	6.67	3.91	2.67	1.72	-0.309
Volatility (%)	10.083	8.2695	4.6917	7.4058	2.2524
Kurtosis	8.2928	8.2091	5.5689	8.3134	3.5697
Skewness	-0.8536	-0.3591	-0.3399	0.0685	-0.0685
Tail Index	1.9332	2.3971	2.1807	2.3268	2.6251

Note: This table represents the risk/return parameters of five currency portfolios, P1, P2, P3 ,P4 and P5. P1 generates the highest yield, whereas P5 generates the lowest. Return and volatility are annualised. Tail index calculated using the log-log-rank-size method, demonstrated in Appendix A.

the returns pattern with the exception of portfolio P4. Reported results in table 4 and table 5, imply that skewness of exchange rate shock does not explain the return of each portfolio even though it explains the return of HML strategies. This contradicts with the findings of Burnside (2009) which conclude that skewness of exchange rate shocks does not explain the excess returns of HML strategy even though it explains the portfolio return. The skewness of returns is captured by the tail index estimation which considers the lowest returns of the distribution. According to the reported results, it is eminent that tail index reduces as skewness become more negative.

Table 6 indicates that if individually accounted, only the long position is significant at 95% level of significance in terms of explaining the overall tail risk of P1-P5 strategy and none of the positions are significant in terms of P2-P5 strategy. As per the results, the returns from each long and short position, does not seem to produce a strong explanation of VaR of the overall strategy in both instances. However the explanatory power decreases with the reduction of overall returns. The long position is significant in the P1-P5 strategy where its contribution remains greater compared to the short position. Therefore the long position is the only significant component for the tail risk of the overall P1-P5 strategy. However, both long and short positions become insignificant when it comes to P2-P5 strategy, as the overall return decreases and subsequently leads to a weaker explanatory power. The results after regressing the overall VaR of the strategy on the individual VaR of each long and short portfolios (Table 7) suggest that the tail risk of the long position of the HML strategy (P1) is more capable of explaining the overall VaR. Further, the results reveal a significant relationship between the VaR components of each position and the VaR of the overall strategy. Both coefficients are significant at the 95 percent level of significance. However the as the return of the long position decreases, *i.e.,* when it comes to P2-P5 strategy, the VaR of the long position is less significant in explaining the VaR of the overall strategy. Subsequently, the $\overline{R^2}$ of the respective regression drops to 66.46 percent which allows me to believe that the tail risk generated by the long side of the strategy influences more on the overall tail risk of the carry trade.

Given the compelling facts, its observable that returns of long position contributes more to the overall risk of the strategy. Literature indicates that if the central banks commit to a less active monetary policy, then it may cut down the probability of substantial fluctuations in exchange rates and therefore reduce the extreme downturns (Plantin and Shin, 2011). Moreover, Eichenbaum and Evans (1995) find that expansionary monetary policy leads to persistent depreciation of exchange rates and therefore it contributes to the volatility of exchange rates.

Steele and Wright (1996) explain that, forward premium bias is caused by rapid changes in monetary policy regimes, forcing the estimates to be incorrect. Further, the return of the long position could be written as $rt = (S_{t+5} - F_{t,t+5}) / S_t$ while the return of the

Table 6: Explaining the tail risk of the investment strategy, through returns of long and short positions.

$$HML_{VaR} = constant + \beta_1 (long_{return}) + \varepsilon \text{------(1)}$$

$$HML_{VaR} = constant + \beta_2 (short_{return}) + \varepsilon \text{------(2)}$$

$$HML_{VaR} = constant + \beta_3 (long_{return}) + \beta_4 (short_{return}) + \varepsilon \text{-----(3)}$$

Panel A : P1-P5 Portfolio							
	β_1	$\overline{R^2}$ %	β_2	$\overline{R^2}$ %	β_3	β_4	$\overline{R^2}$ %
Coefficient	0.2561		0.1662		0.2923	-0.1530	
S.E.	(0.0495)	0.96	(0.1068)	0.05	(0.0575)	(0.1235)	0.98
t-Statistic	5.1719		1.5555		5.0840	-1.2391	
Panel B : P2-P5 Portfolio							
	β_1	$\overline{R^2}$ %	β_2	$\overline{R^2}$ %	β_3	β_4	$\overline{R^2}$ %
Coefficient	0.0095		0.0212		0.0013	0.0196	
S.E.	(0.0075)	0.02	(0.0132)	0.05	(0.0111)	(0.0197)	0.02
t-Statistic	1.2582		1.6019		0.1130	0.9975	

Note: This table reports the analysis for contribution of each long and short return components of the carry trade, towards the tail risk of overall investment strategy. Panel A contains relevant information for carry strategy P1-P5 and, Panel B contains information for carry strategy P2-P5. Further, this table exhibits regression results of each portfolio on VaR of the overall strategy. The second and third columns represent the results for regression (1). Results for regression (2) are reported in columns four and five, while columns six, seven and eight exhibit the results for regression (3). All the standard errors (S.E.) are generated by the Newey-West Estimator (Newey and West, 1987).

Table 7: Testing the Influence of the tail risk embedded in long and short positions of the carry trade on the tail risk of the investment strategy.

$$HML_{VaR} = constant + \beta_1\,(long_{\,VaR}) + \varepsilon\text{-----(1)}$$

$$HML_{VaR} = constant + \beta_2\,(short_{\,VaR}) + \varepsilon\text{-----(2)}$$

$$HML_{VaR} = constant + \beta_3\,(long_{\,VaR}) + \beta_4\,(short_{\,VaR}) + \varepsilon\text{----------(3)}$$

Panel A : P1-P5 Portfolio							
	β_1	$\overline{R^2}$ %	β_2	$\overline{R^2}$ %	β_3	β_4	$\overline{R^2}$ %
Coefficient	0.7590		0.0012		0.8147	-0.0015	
S.E.	(0.0280)	69.27	(0.0005)	2.11	(0.0286)	(0.0003)	71.85
t-Statistic	27.107		2.2556		28.486	2.9875	
Panel B : P2-P5 Portfolio							
	β_1	$\overline{R^2}$ %	β_2	$\overline{R^2}$ %	β_3	β_4	$\overline{R^2}$ %
Coefficient	0.3039		0.0011		0.4164	-0.0005	
S.E.	(0.0171)	53.20	(0.0005)	2.02	(0.0178)	(0.0002)	66.46
t-Statistic	17.772		2.2001		23.3932	2.2530	

Note: This table reports regression results in view of analysing the influence of the tail risk of each long and short positions of the carry trade, towards the tail risk of overall investment strategy. Panel A contains relevant information for carry strategy P1-P5 and, Panel B contains information for carry strategy P2-P5. Further, this table exhibits regression results of each portfolio on VaR of the overall strategy. The second and third columns represent the results for regression (1). Results for regression (2) are reported in columns four and five, while columns six, seven and eight exhibit the results for regression (3). All the standard errors (S.E.) are generated by the Newey-West Estimator (Newey and West, 1987).

short position is $rt = -(S_{t+5} - F_{t,t+5}) / S_t$. Moreover, if the volatility of a particular exchange rate is relatively higher than others, it increases the investors' uncertainty of purchasing back the sold currency at the expected rate, at time t+5. Therefore the volatility of exchange rates has a positive effect on the volatility of overall returns of the respective HML strategy. Further, low volatile currencies will provide an assurance against the high volatility of the long position (Menkhoff *et al*. 2012a). Motivated by the strong literature stated above, the volatility of de-trended money supply (M2) is used as a measure to explain the respective causes of tail risk.

According to Table 8, it is clearly observed that the volatility of de-trended money supply for the countries that reside in long position (P1) is substantially higher than the short position (P5). Backed by strong evidence, this implies that volatility of exchange rates of those currencies in P1 is much greater than that of the currencies in P2 or P5. Results indicate that, the magnitude of volatility in P1 has been hedged by the short position and consequently, the volatility of the overall strategy is less than the volatility of P1.Therefore, in the context of this research it is eminent that, long position is the greater contributor of risk to the tail risk of the overall strategy. Ferreira *et al*. (2013) find that, long positions of carry trades are more risky in terms of funding. When a typical carry trader prefers to exit a trade, he/she will sell the currencies in the long position and purchase the currencies in the short position. Sudden selling pressure on a relatively illiquid currency will depreciate the currency forcing the currency to crash.

Table 8: Volatility of the change in Money Supply

P1		P2		P5	
Currency	**Volatility %**	**Currency**	**Volatility %**	**Currency**	**Volatility %**
BRL	5.509	PLN	3.650	EUR	1.386
ARS	15.625	PHP	9.617	GBP	1.348
NZD	7.564	HUF	4.953	HKD	7.061
TRY	5.447	THB	3.646	TWD	1.862
AUD	3.009	ILS	3.665	JPY	1.509
Portfolio	**5.432**	**Portfolio**	**2.982**	**Portfolio**	**1.150**

Note: This table presents the annualised volatility statistics for the monthly change in money supply (M2). Assuming that there is no correlation of money supply between two countries since monetary policy of each country is independent from each other, Volatility of the portfolio could be written as,

$$\sqrt{\sum_{i=1}^{5} w_i^2 * \sigma_i^2}$$

w_i is the weight assigned portfolio wise, according to the USD value of money supply in each economy and σ_i^2 is the annual volatility of the change in money supply

4.3 Impact of returns and tail risk on Forex and interest rate return components

The research is extended further to find the root cause of the tail risk that is inherited by each strategy, soon after exploring the impact of HML returns and long short positions, on its tail risk. Relevant information on forex and interest rate returns presented in table 9 suggests that interest rate component of the strategy generate more returns compared to the forex component. The fourth moment of returns imply that, interest rate component holds more risk compared to the forex component. However the volatility, skewness and tail risk conveys that forex component is more capable of producing extreme losses, further supported by clearly visible heavy tails in the histogram of forex returns (Figure 5). Further, there is a possibility of extreme losses to significantly reduce with the decrease in overall returns (in P2-P5 strategy). However this behaviour of the forex component is rather confusing, considering the low gain after having exposed to more extreme losses.

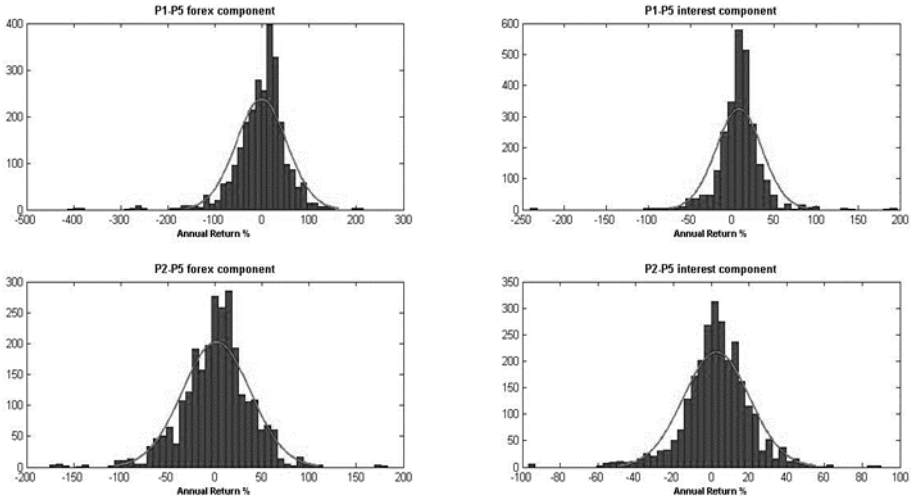
Table 9: The risk/return parameters of forex and interest rate return components.

Panel A : P1-P5 Portfolio					
Portfolio	**Return %**	**Volatility %**	**Kurtosis**	**Skew**	**Tail Index**
Forex	-1.2551	7.787	9.0352	-1.518	1.366
Interest	8.0326	3.966	12.721	-0.835	1.800
Panel B : P2-P5 Portfolio					
Portfolio	**Return %**	**Volatility %**	**Kurtosis**	**Skew**	**Tail Index**
Forex	-0.7731	5.208	11.041	-0.389	1.564
Interest	5.6296	2.520	10.388	-0.385	1.915

Note: This table represents the risk/return parameters of each forex and interest rate return components of the carry trade. Panel A contains relevant information for carry strategy P1-P3 and, Panel B contains information for carry strategy P2-P3. Further, this table exhibits regression results of each portfolio on VaR of the overall strategy. Tail index calculated using the log-log-rank-size method, demonstrated in Appendix A.

Table 10 reports the regression results of forex and interest rate return components of each portfolio on the tail risk of the respective strategy. Only the Forex return as an individual element is significant at 95 percent level of confidence, towards the explanation of the overall tail risk of the P1-P5 strategy. Neither forex nor interest rate components are significant in terms of explaining the tail risk of P2-P5. Further, the regression of the overall tail risk of the strategy P1-P5 on to forex and interest rate components strengthens the earlier result that only the forex component is significant at the 95 percent level of significance. However the explanatory powers of these regressions (*i.e.,* Table 10 [1], [2] and [3]) are substantially weak and it further reduces with the overall return.

Figure 5: Forex and interest rate return of carry trades



Note: The graph represents the histograms of each forex and interest rate return component of each HML strategy. Red line indicates the normal distribution of the same mean and variance. All returns are annualised. The top two graphs represent the histograms for forex and interest rate returns of the P1-P5 strategy. Forex and interest rate components for the P2-P5 strategy reside at the bottom. Time period runs from March 2004 to June 2014. All the histograms are fitted with the relevant normal distribution.

Table 10: Explaining the tail risk of the investment strategy, through the returns of forex and interest components.

$$\boldsymbol{HML_{VaR} = constant + \beta_1 (forex_{return}) + \varepsilon}\text{------(1)}$$

$$\boldsymbol{HML_{VaR} = constant + \beta_2 (Interest_{return}) + \varepsilon}\text{-----(2)}$$

$$\boldsymbol{VaR = constant + \beta_3 (forex_{return}) + \beta_4 (Interest_{return}) + \varepsilon}\text{-----(3)}$$

Panel A : P1-P5 Portfolio							
	$\boldsymbol{\beta_1}$	$\boldsymbol{\overline{R^2}}$ %	$\boldsymbol{\beta_2}$	$\boldsymbol{\overline{R^2}}$ %	$\boldsymbol{\beta_3}$	$\boldsymbol{\beta_4}$	$\boldsymbol{\overline{R^2}}$ %
Coefficient	0.4075		0.1628		0.4024	0.1414	
S.E.	(0.0759)	1.04	(0.0927)	0.07	(0.0760)	(0.0923)	1.09
t-Statistic	5.3681		1.7560		5.2973	1.5314	
Panel B : P2-P5 Portfolio							
	$\boldsymbol{\beta_1}$	$\boldsymbol{\overline{R^2}}$ %	$\boldsymbol{\beta_2}$	$\boldsymbol{\overline{R^2}}$ %	$\boldsymbol{\beta_3}$	$\boldsymbol{\beta_4}$	$\boldsymbol{\overline{R^2}}$ %
Coefficient	0.0241		-0.0217		0.0242	-0.0219	
S.E.	(0.0141)	0.07	(0.0170)	0.02	(0.0128)	(0.0170)	0.09
t-Statistic	1.7115		-1.2765		1.7210	-1.2893	

Note: This table reports the analysis for contribution of each forex and interest rate return components of the carry trade, towards the tail risk of overall investment strategy. Panel A contains relevant information for carry strategy P1-P5 and, Panel B contains information for carry strategy P2-P5. The second and third columns represent the results for regression (1). Results for regression (2) are reported in columns four and five, while columns six, seven and eight exhibit the results for regression (3). All the standard errors (S.E.) are generated by the Newey-West Estimator.

Table 11: The influence of tail risk embedded in forex and interest rate return components on the tail risk of the investment strategy.

$$HML_{VaR} = constant + \beta_1 (forex_{VaR}) + \varepsilon \text{-----(1)}$$

$$HML_{VaR} = constant + \beta_2 (Interest_{VaR}) + \varepsilon \text{-----(2)}$$

$$HML_{VaR} = constant + \beta_3 (forex_{VaR}) + \beta_4 (Interest_{VaR}) + \varepsilon \text{----------(3)}$$

Panel A : P1-P5 Portfolio							
	β_1	$\overline{R^2}$ %	β_2	$\overline{R^2}$ %	β_3	β_4	$\overline{R^2}$ %
Coefficient	1.5143		0.4656		1.3227	0.1741	
S.E.	(0.0864)	70.73	(0.0332)	33.39	(0.0598)	(0.0283)	74.27
t-Statistic	17.526		14.024		22.118	6.152	
Panel B : P2-P5 Portfolio							
	β_1	$\overline{R^2}$ %	β_2	$\overline{R^2}$ %	β_3	β_4	$\overline{R^2}$ %
Coefficient	1.3038		0.4136		1.1554	0.2517	
S.E.	(0.0457)	69.09	(0.0298)	29.24	(0.0344)	(0.0201)	79.02
t-Statistic	28.529		13.879		33.587	12.522	

Note: This table reports the analysis for contribution of tail risk associated with each long and short return component of the carry trade, towards the tail risk of overall investment strategy. Panel A contains relevant information for carry strategy P1-P5 and, Panel B contains information for carry strategy P2-P5. The second and third columns represent the results for regression (1). Results for regression (2) are reported in columns four and five, while columns six, seven and eight exhibit the results for regression (3). All standard errors (S.E.) are generated by the Newey-West Estimator.

Table 11 presents the regression results of VaR of the overall strategy on the respective tail risk of forex and/or interest rate component. Even though the forex component generate a negative average return, it is significance of tail risk in explaining the tail risk of the overall strategy, P1-P5 remains greater than that of interest rate component. Moreover, the results from the regression of VaR of the overall strategy, collectively on forex and interest rate return (Table 11 regression [3]) agrees with its behaviour of forex and interest rate as individual components. Even though the returns of forex and interest rate returns hold a very limited explanation of overall VaR, the VaR of forex and interest rate components suggest that, the VaR of forex return explains the overall risk more than the VaR of the respective interest rate component. Despite the consistent significance and sensitivity of the VaR of forex component, the significance and the sensitivity of the VaR of interest rate component on the overall VaR increases as the return of the overall strategy declines.

Moving forward, Arratibel and Michaelis (2014) explain that exchange rates converge to zero much faster due to a unit monetary policy shock. In contrast, the interest rate response appears to be stable across time. Earlier findings of Kearns and Manners (2006) state that the impact of monetary policy on exchange rates are almost instantaneous even though it only explains a limited portion of exchange rate volatility. Therefore, it is eminent that monetary shocks influence the exchange rates more rapidly than interest rates which increase volatility. Increased exchange rate volatility assures that the impact of exchange rates on the overall tail risk is more pronounced.

4.4 Impact of returns and tail risk of Forex and interest rate return components belong to long and short positions

Thus far the research examined the tail risk induced by the long/short positions and forex/ interest rate components on the HML strategy. Table 12 reports the summary results of a regression in order to analyse the collective impact of forex and interest rate return/tail risk embedded each long and short positions on the tail risk of HML strategy.

Results in Panel A indicate the null hypothesis that forex return, interest rate return of the short position and interest rate return of the long position are insignificant, cannot be rejected at 95% significance level, implying the forex return of the long position is the only significant component when it comes to explaining the VaR of HML strategy. However the explanatory power of the regression remains weak with a low $\overline{R^2}$ value. Panel B represents the results regression of the return and VaR components from P2-P5 strategy. In this case, neither the interest rate nor forex component of both long and short positions is reported to be significant at the 95 percent level of significance. Further, the regression of VaR of the HML strategy on the forex and interest rate components of both long and short positions (Table 13) are estimated, in order to find the most powerful influence on the overall tail risk.

Table 12: Explaining the tail risk of the investment strategy, through returns of forex and interest rate components in each long and short positions.

$$HML_{VaR} = constant + \beta_1\,(long\ IR_{return}) + \beta_2\,(long\ FX_{return}) + \beta_3\,(Short\ IR_{return}) + \beta_4\,(Short\ FX_{return}) + \varepsilon$$

Panel A : P1-P5 Portfolio					
	β_1	β_2	β_3	β_4	$\overline{R^2}$ %
Coefficient	0.1382	0.3981	-0.0847	-0.2024	
S.E.	(0.0924)	(0.0760)	(0.1937)	(0.1577)	1.10
t-Statistic	1.4962	5.2374	-0.4374	-1.2831	
Panel B : P2-P5 Portfolio					
	β_1	β_2	β_3	β_4	$\overline{R^2}$ %
Coefficient	-0.0241	-0.0189	0.0343	0.0069	
S.E.	(0.0172)	(0.0145)	(0.0292)	(0.0250)	0.11
t-Statistic	-1.4000	1.3063	1.1757	0.2781	

Note: This table represents the regression results in view of estimating the influence of forex and interest rate return in each long and short position of the carry trade, towards the tail risk of overall investment strategy. Panel A contains relevant information for carry strategy P1-P5 and, Panel B contains information for carry strategy P2-P5. All the standard errors (S.E.) are generated by the Newey-West Estimator.

Table 13: Explaining the tail risk of the investment strategy, through tail risk of forex and interest rate components in each long and short positions.

$$HML_{VaR} = constant + \beta_1\,(long\ IR_{VaR}) + \beta_2\,(long\ FX_{VaR}) + \beta_3\,(Short\ IR_{VaR}) + \beta_4\,(Short\ FX_{VaR}) + \varepsilon$$

Panel A : P1-P5 Portfolio					
	β_1	β_2	β_3	β_4	$\overline{R^2}$ %
Coefficient	0.1546	1.0893	-1.7225	-4.0649	56.38
S.E.	(0.0346)	(0.0784)	(0.9575)	(1.2436)	
t-Statistic	4.4682	13.894	1.7989	3.2686	
Panel B : P2-P5 Portfolio					
	β_1	β_2	β_3	β_4	$\overline{R^2}$ %
Coefficient	0.1514	0.5418	-0.9322	-1.0030	
S.E.	(0.0202)	(0.0375)	(0.1346)	(0.1558)	49.47
t-Statistic	7.4950	15.248	0.4584	6.4377	

Note: This table represents the Newey-West regression results of the tail risk associated with each forex and interest rate return component present in each long and short position of the carry trade, and its influence on the tail risk of overall investment strategy. Panel A contains relevant information for carry strategy P1-P5 and, Panel B contains information for carry strategy P2-P5. All the standard errors (S.E.) are generated by the Newey-West Estimator.

The results on each panel A and B suggest the null hypothesis that the coefficients of forex return, interest rate return of the long position and interest rate return of the short position are statistically insignificant at the 95 percent significance level. Other than the interest rate component of the short position, the significance of all coefficients increase with the decrease in returns. However the explanatory power decreases with the overall return of the strategy. The results given above (Table 12 and 13) demonstrate that, out of the four return components mentioned, the forex return of the long position is the only component capable of explaining the tail risk of the strategy.

Furthermore, the tail risk of the forex component that is embedded in the long position is reported to be the most significant component that affects the overall tail risk of the strategy. Therefore, the forex component of the long position is undoubtedly the most influential component on the overall tail risk at 95 percent significance.

The previous sections explain the impact of money supply on the volatility of the exchange rates and its speed of impact on exchange rate as well as interest rates, which lead to the conclusion that the tail risk of HML strategy is substantially influenced by the long position and the forex component of carry trade return. Therefore as a corollary, this research reports that the tail risk of carry trades is most influenced by the forex component of the long position.

5. Conclusion

This research was designed to analyse the origin of the tail risk of a potential HML strategy which is a popular investment style in the context of forex. Existing studies in this field of research have proven the existence of a crash risk premium that explains the expected returns. However the research focuses on tail risk exposure of an investor as a result of carry trades in order to provide the risk managers and regulators with a critical explanation of where things can go wrong. Consequently, this research applies the concepts of extreme value theory in order to estimate the tail risk induced as a result of a potential carry trade opportunity.

A new method was proposed in view of estimating the cumulative distribution function of the left tail of the returns distribution with the application of purely based on power law distribution. Further, the measure for tail risk is established using the implied volatility of returns estimated through GARCH (1,1) model and the corresponding cumulative distribution function of the returns distribution. This measure produces a better estimate of tail risk especially in the case of heavy left tails where normal and student-t distributions cannot reach. Further, a better estimate of tail risk is observed even when the currency returns are not heavy tailed, since this method captures the actual shape of each return

distribution. Having observed its effectiveness, this research utilizes the same method in order to estimate the VaR of a potential carry trade.

The research finds that, the returns of the HML strategy bears a weak explanatory power over the VaR of its returns and it diminished with the overall return. When the returns are low under low volatility conditions, the VaR of the strategy converges close to a minimal level. Moreover, when there are signs of a crisis such as, patches of volatility clusters and high volatility climate, the VaR estimation models behave more responsively.

Further the analysis indicates that the skewness and the tail index explain the risk return relationship of the HML strategy even though it may not be the case in the context of portfolios as well as forex and interest rate components of the HML strategy. Regression results and existing literature suggest that long position of the trade explains the VaR of the overall strategy better than the short position and moreover, the forex component dominates over the interest rate component in terms of explaining the overall tail risk. Therefore this research concludes that, the forex return of the long position of the trade is the most influential component that is responsible for the tail risk of the overall strategy. However, results show that carry trade returns have a weaker explanatory power on the respective tail risk. According to the findings of this research, countries with high volatility of monetary aggregates are incorporated with a higher tail risk. Therefore, the tail risk increases with the activities leading to such variations in the domestic monetary aggregates. These situations may occur either due to a sudden withdrawal or an injection of money by an external party, such as a foreign investor or because of an internal policy decision made by the Central bank.

This research follows the method by Ibragimov *et al*. (2013), which truncates the dataset by 10 percent, in order to eliminate the most extreme values that would hinder the estimation of tail index. However, this method could be further extended with truncation independent VaR estimation methods, so that the entire range of observations could be utilized to determine the heavy-tailedness of the returns distribution.

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Appendix A

According to power law, we have,

$$\Pr(X > x) \approx \frac{C}{x^{\zeta}}$$

$$\log \Pr(X > x) \approx c - \zeta \log(x)$$

Since we are interested in the left tail of the distribution, order the observations such that

$$X_1 \leq X_2 \leq X_3 \ldots\ldots \leq X_n \ldots\ldots\ldots\ldots\ldots \leq X_N$$

This research uses the truncation value 10 percent such that, n=N*10%

Taking x= X_k we have

$$\Pr(X > x) = \Pr(X > X_k) \approx \frac{k}{N} = Rank$$

Therefore we have the log-log rank-size regression as

$$\boldsymbol{\log(Rank) \approx c - \zeta \log(X_k)}$$

Further I employ the constant $\gamma = 0.5$ introduced in to the above regression by (Gabaix, Ibragimov 2011) in order to make the analysis more robust.

$$\boldsymbol{\log(Rank - \gamma) \approx c - \zeta \log(X_k)}$$

Appendix B

According to power laws, the Probability Density Function (pdf) is $p(x)$,

$$p(x) = \frac{\zeta - 1}{X_{min}} \left(\frac{x}{X_{min}} \right)^{-\zeta}$$

Where, X_{min} is the minimum value of returns and ζ is the tail index of the distribution as calculated in Appendix A. In the scenario of tail risk, it's essential to focus this research on the left tail of the power law distribution. Therefore, in order to determine the Cumulative Density Function (cdf), the pdf will be integrated w.r.t. x between X_{min} and x.

$$\text{P(X)= Pr(X<=x)} = \int_{X_{min}}^{x} \frac{\zeta - 1}{X_{min}} \left(\frac{X}{X_{min}} \right)^{-\zeta} dx$$

Since X_{min} and ζ are constants,

$$\text{Pr(X<=x)} = \frac{\zeta - 1}{{X_{min}}^{-\zeta+1}} \int_{X_{min}}^{x} (X)^{-\zeta} dx$$

After integrating and applying limits;

$$\Pr(X<=x) = 1 - \left(\frac{X_{min}}{x}\right)^{\zeta-1}$$

If p is the probability that returns fall below the threshold then the (1-p)th quantile of the power law distribution Z_p is

$$Z_p = \frac{X_{min}}{\sqrt[\zeta-1]{p}}$$

Further, p is the conditional probability that $x \geq X_{min}$ and therefore,

$$p = Pr(\mathrm{x} \geq \mathrm{VaR}_{a\%} | \mathrm{x} \geq X_{min}) = \frac{Pr(\mathrm{x} \geq \mathrm{VaR}_{a\%} \cap \mathrm{x} \geq X_{min})}{\Pr(x \geq X_{min})}$$

$$= \frac{Pr(\mathrm{x} \geq \mathrm{VaR}_{a\%})}{\Pr(x \geq X_{min})} = \frac{a\%}{Truncation\,\%}$$

Appendix C

Estimating daily returns earned through a one week carry trade

I write the carry trade return for a period one week as,

$$R_t = (S_{t+5} - F_{t,t+5})/S_t$$

Decomposing the original formula gain at time t will be

$$\frac{(S_{t+5} - F_{t,t+5})}{S_t} = \frac{(S_{t+5} - S_{t+4})}{S_t} + \frac{(S_{t+4} - S_{t+3})}{S_t} + \cdots + \frac{(S_{t+1} - S_t)}{S_t} + \frac{(S_t - F_{t,t+5})}{S_t}$$

Further, gain of the carry trade at time t+1 will be

$$\frac{(S_{t+5} - F_{t,t+5})}{S_{t+1}} = \frac{(S_{t+5} - S_{t+4})}{S_{t+1}} + \frac{(S_{t+4} - S_{t+3})}{S_{t+1}} + \cdots + \frac{(S_{t+2} - S_{t+1})}{S_{t+1}} + \frac{(S_{t+1} - F_{t,t+5})}{S_{t+1}}$$

Estimating daily forex and interest rate returns earned through a one week carry trade

I reconsider the initial decomposition to estimate the carry trade return at time t

$$\frac{(S_{t+5}-F_{t,t+5})}{S_t}=\frac{(S_{t+5}-S_{t+4})}{S_t}+\frac{(S_{t+4}-S_{t+3})}{S_t}+\cdots+\frac{(S_{t+1}-S_t)}{S_t}+\frac{(S_t-F_{t,t+5})}{S_t}$$

After combining all terms except the last term, I get;

$$\frac{(S_{t+5}-F_{t,t+5})}{S_t}=\underbrace{\frac{(S_{t+5}-S_t)}{S_t}}_{\text{Forex return}}+\underbrace{\frac{(S_t-F_{t,t+5})}{S_t}}_{\text{Interest rate return}}$$