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The Impact of Foreign Direct Investment Spillover Effects on Total Factor Productivity in Sri Lanka

Kalaichevi Ravinthirakumaran, Tarlok Singh, Eliyathamby Selvanathan & Saroja Selvanathan

Abstract - This paper examines whether FDI generates productivity spillovers in Sri Lanka, using the annual data over the period from 1978 to 2015. The autoregressive distributed lag model has been estimated to investigate the effects of FDI, research and development, human capital, international trade, technological gap, rate of inflation, population growth and civil war on total factor productivity (TFP). The results reveal that FDI positively influences TFP. The results also confirm that research and development, human capital and international trade have positive effects. The findings suggest that Sri Lanka needs to increase investment in human capital and in research and development and needs to introduce policies to attract FDI inflows.

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I. Introduction

Over the last three decades, in many developing countries, FDI has been considered to be an element of a development strategy. Most countries today recognize that FDI can play a significant role in economic growth and development. It is widely believed that the inflows of FDI are beneficial to host countries in terms of providing additional capital, creating jobs, and accelerating economic growth. Many countries rely, to a large extent, on the assumption that FDI generates positive externalities in the host country (Caves, 1974; Javorcik, 2004; Branstetter, 2006; Liu, 2008; Hoi and Pomfret, 2010; Tang et al., 2012; Baltabaev, 2014; Liu et al., 2016; Thang et al., 2016; Zhang, 2017). Generally, a foreign presence in any sector is associated with technical knowledge and managerial know-how that not only improves the productivity but also creates spillover into the economy, however, according to Moura and Forte, 2009; Del Bo, 2013; Herzer and Donaubauer (2018) the spillover effects of FDI can negatively affect growth through the host country. Therefore, an understanding of the spillover effects of FDI is very significant in the economy.

Dunning’s research work (1977, 1981) provides a comprehensive analysis based on ownership, location and, the internalization (OLI) paradigm (eclectic theory). The United Nations Conference on Trade and Development (UNCTAD, 1998), applying Dunning’s OLI paradigm, confirms that FDI tends to go to countries where it is possible to combine the ownership advantages with the location-specific of the host countries through the internalization of foreign investments.

Productivity spillovers take place through contacts between Multinational Enterprises (MNEs) and domestic firms. Both the neoclassical and endogenous growth models support the proposition that FDI can generate positive spillovers to firms in the host country. Since MNEs are part of international capital and technology, their entry into a country can facilitate the transfer of technology and business know-how. MNEs can also provide both training for staff and managers and technical assistance to local suppliers, leading to improved productivity and competitiveness in the local firms in the host country. According to Crespo and Fontoura (2007), FDI spillovers can occur through five main channels: (i) demonstration/imitation, (ii) labor mobility, (iii) exports, (iv) competition, and (v) backward and forward linkages with domestic firms. Thus, the demonstration effect may help firms imitate product and process technologies. In domestic sectors, labor mobility could allow the hiring of workers from foreign firms. By permitting foreign firms to export, domestic firms could enter the market with lower costs. The competitive atmosphere in the host country provides an incentive for using the existing resources and technology more efficiently. When domestic firms establish local markets in which MNEs are buyers (backward linkages) or sellers of intermediate inputs (forward linkages), linkages are created. These five channels of the spillover effects of FDI to the domestic industries can be classified into two forms: (a) intra-industry (horizontal FDI) and (b) inter-industry (vertical FDI). Horizontal spillover takes place when MNEs carry out the same activities in the host country as at home. Vertical spillover arises from the MNEs engaging in different stages of activities in the host country.

The objective of this research is to investigate the impact of FDI on total factor productivity (TFP) in Sri Lanka.
Lanka. This study contributes to the spillover effect of FDI literature in the following ways. First, to our knowledge, this is the first study to investigate the relationship between FDI and TFP in Sri Lanka. Second, we have employed a more recent econometric technique, the Autoregressive Distributed Lag (ARDL) approach. This method, in our estimation, captures the short-run and long-run effects of the relationship between FDI and TFP. It is believed that analyzing these effects of the relationship between FDI and TFP is more useful to design policies at different time horizons. Third, this study uses more recent data. The rest of the paper is organized as follows. Section 2 reviews the relevant theoretical and empirical literature on FDI and spillovers. Section 3 briefly describes the Sri Lankan economy. Section 4 demonstrates model specification for the relationship between FDI and total factor productivity. Section 5 describes the variables and data sources. Section 6 presents the empirical analysis and estimation results. Section 7 comprises the conclusions and policy implications.

II. FDI AND SPILLOVERS: A REVIEW OF THE LITERATURE

a) Theories of FDI

The theoretical models for FDI and spillovers fall within the frameworks of the theories of growth and FDI. The neoclassical growth model of Solow (1956) shows that output growth is linked to increases in labor and capital, and the progress in technology. The lack of economic growth in many countries is due to the nature of their production and technological constraints that inhibit their capacity to obtain the necessary technology required to increase their productivity, thus reducing economic growth. The FDI becomes an ingredient in many countries to promote growth and to be capable of maximizing the utilization of existing productive capabilities and the opportunities of creating new ones.

The endogenous growth theory (Romer, 1986; Lucas, 1988) treats technological advances as an endogenous factor. It stimulated research on the path by which FDI accelerates a country’s economic growth in the long-run by way of two ways. First, FDI advances new foreign technology or imports new intermediary goods in the production function and accelerates economic growth by fuelling capital accumulation in capital import countries. Second, FDI enhances economic growth by contributing to the accumulation of human capital using labor training or absorption of technology and new management techniques. In the endogenous growth models, FDI raises growth through technological diffusion from the developed countries to the developing countries. Helpman (2004) argues that the range of available products and the stock of knowledge accessible for Research and Development (R&D) are the channels through which investment affects economic growth.

Considering the FDI theories, Hymer (1976) introduces the concept of firm-specific advantages and demonstrates that FDI takes place only when the benefits of exploiting firm-specific advantages outweigh the relative costs of the operations abroad. The firm-specific advantages are in the form of brand name, patent-protected superior technology, marketing, and managerial skills, cheaper sources of financing, preferential access to markets, and economies of scale. Kindleberger (1970) agrees with Hymer that firms invest abroad because of the possession of monopolistic advantages such as product differentiation, marketing skills in the goods market, proprietary knowledge, discrimination in access to capital, and managerial skills in factor markets. Viewed this way, FDI creates spillovers into the host country.

Findlay (1978), one of the pioneers of FDI spillovers theory, investigates the relationship between FDI and technological change in a backward region. In this model, the rate of technological progress in the advanced region was assumed to increase at a constant rate. His model based on the earlier ideas of the relative backwardness of Gerschenkron (1962), states that the greater relative disparity in development levels between the backward country and the advanced country, the faster the catch-up rate. Findlay (1978) then proposes a hypothesis that the technological progress in a ‘backward’ region is an increasing function of the technology gap between it and the ‘advanced’ region. Moreover, Findlay followed the idea of diffusion of technology, suggested by Arrow (1971), considering it an analogy of the spread of a contagious disease. The basis of the analogy was that technological innovations are most efficiently diffused when there is personal contact between those with the knowledge of the innovation and those who adopt it. In this way, Findlay (1978) formalized the Hymer approach to endogenize the rate of technological change in the backward region as a function of the degree to which it is exposed to FDI.

b) Empirical Studies

During the last three decades, numerous empirical studies have investigated the relationship between FDI and spillovers in both developed and developing countries. The spillover effects of FDI attracted relatively more attention with the pioneer study coming from Caves (1974). Previous studies focus on exploring the channels of technological diffusion from MNEs to the host countries. In the literature, FDI–spillover relationship has been investigated based on , industry-level, and country-specific data. However, the majority of the studies have been conducted using data.

Table 1 presents a summary of the studies on FDI and spillovers, based on the data period, country of
study, type of methodology used, and their findings. As can be seen, results from most of the empirical studies reveal that FDI brings positive externalities to host countries. That is, FDI positively affects productivity (Caves, 1974; Cheung and Lin, 2004; Javorcik, 2004; Branstetter, 2006; Sasidharan, 2006; Liu, 2008; Hoi and Pomfret, 2010; Piyaareekul and Peridy, 2010; Fu, 2012; Karunaratne, 2012; Tang et al., 2012; Baltabaev, 2014; Lenaerts and Merlevede, 2015; Liu et al., 2016; Thang et al., 2016; Zhang, 2017); however, Del Bo (2013) finds a negative effect of FDI on productivity. Bruhn and Calegario, 2014; Lenaerts and Merlevede, 2015; Liu et al., 2016; Thang et al. (2016) confirm that FDI both positively and negatively affects productivity when considering the forward and backward linkages, capital intensive and labor intensive capacity, as well as the short and longruns.

Studies by Aitken and Harrison (1999), Cheung and Lin (2004), Javorcik (2004), Branstetter (2006), Sasidharan (2006), Liu (2008), Hoi and Pomfret (2010), Fu (2012) and Del Bo (2013) provide evidence of FDI spillovers through vertical or/and horizontal channels. Among the reviewed studies, some studies (Piyaareekul and Peridy, 2010; Karunaratne, 2012; Del Bo, 2013; Baltabaev, 2014; Bruhn and Calegario, 2014; Lenaerts and Merlevede, 2015; Thang et al., 2016) have used total factor productivity to measure the spillover effects, while others such as Caves (1974), Kokko et al. (1996) and Buckley et al. (2007) have used labor productivity. Attempting to establish the relationship between FDI and spillovers from the review of the findings reveals a mix of positive and negative relationships between FDI and spillovers. This may be due to data sets, the alternative econometric methods, and the different country characteristics.

Table 1: Empirical Studies on the Spillover Effects of FDI: A Summary

| Author(s), Year | Period | Country | Technique | Variables | Findings |
|-----------------|--------|---------|-----------|-----------|----------|
| Caves (1974)    | 1965 – 1967 | Canada and Australia | OLS | Value added per worker, foreign-owned firms' share of industry, average profit on equity, sales by corporations and total assets of firms | Higher subsidiary shares make higher productivity levels in competing domestic firms. |
| Kokko et al. (1996) | 1988 | Uruguay | OLS | Labour productivity, capital-intensity, plant’s capacity utilization, use of disembodied proprietary technology, labour quality, plant’s share of total sales and FDI technology gap | Spillovers effect is positive and statistically significant in the sub-sample of plants with moderate technology gaps compared to foreign firms, but not in the group of local plants facing large technology gaps. |
| Aitken and Harrison (1999) | 1976 – 1989 | Venezuela | OLS and WLS | Output, foreign ownership in the plant, foreign ownership in the sector, and number of plants | A negative spillover from FDI to domestic enterprises. |
| Schoors and Tol (2002) | 1997 – 1998 | Hungary | OLS | Output, fixed assets, human capital and Firm’s sales | Foreign firms have a positive spillover effect on labour productivity of local firms in the same sector; spillover effects between sectors are found to be relatively more important than spillover effects within sectors. |
| Cheung and Lin (2004) | 1995 – 2000 | China | OLS | R&D inputs, expenditures on science and technical development, number of technical personnel, export-output ratio, level of per capita and FDI | Among the three spillovers channels, backward linkages are statistically the most important channel through which technology spillovers from FDI to domestic firms. |
| Javorcik (2004) | 1996 – 2000 | Lithuania | OLS | Real output, capital, labour, material inputs, firm’s total equity, horizontal, backward and forward FDI | There are positive intra industry spillovers from FDI. |
| Branstetter (2006) | 1980 – 1997 | Japan and America | OLS | U.S. patent applications of Japanese firm, FDI, R&D expenditure and firm’s age | FDI is a channel of knowledge spillovers, both from investing firms to indigenous firms and from indigenous firms to investing firms. Vertical spillovers are positive and significant; horizontal is negative and is not statistically significant. |
| Sasidharan (2006) | 1994 – 2002 | India | OLS | Output, capital, labour, material cost, horizontal and vertical FDI | The relationship between HMT capital and locally owned enterprises productivity is curvilinear. |
| Buckley et al. (2007) | 1995 | Chinese overseas firms (Hong Kong, Macau and Taiwan- HMT) | OLS | Labour productivity, capital intensity, R&D intensity, labour quality, firm’s size, HMT firm (Hong Kong, Macau and Taiwan) capital share and other capital share | No support for the hypothesis that spillovers are greater for FDI with more advanced technology. |
| Gorodnichenko et al. (2007) | 2002 – 2005 | 17 Transition countries | OLS | Sales revenues, forward, backward and horizontal FDI, exports, imports, a firm’s | |

Source: Global Journal of Management and Business Research, Volume XX, Issue I, Version I, Year 2020.
| Author(s)               | Year       | Country(s)                  | Methodology | Variables                                                                 | Findings/Results                                                                 |
|------------------------|------------|-----------------------------|-------------|---------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Liu (2008)             | 1995-1999  | China                       | OLS         | Output, capital stock, employees, TFP, foreign equity weighted average of firm's equity owned by foreign investors at industry level and weighted average of FDI in upstream and downstream | Among the three spillovers channels, backward linkages are statistically the most important channel through which technology spillovers from foreign-invested to domestic firms. |
| Hoi and Pomfret (2010) | 2000-2005  | Vietnam                     | OLS         | Wages per employee in a domestic private firm, horizontal and vertical wage spillovers(training activities of foreign firms), capital intensity, skills, scale, concentration and technology gap | Horizontal wage spillovers from foreign firms to domestic private firms; vertical wage spillovers exist, but depend on the specific characteristics of firms and industries. |
| Piyareekul and Peridy (2010) | 1970-2005 | Indonesia, Malaysia, Philippines, Singapore and Thailand | Yamamoto Granger causality test and ECM | FDI and TFP | Positive productivity spillovers effects from inward FDI in all the selected ASEAN countries. |
| Fu (2012)              | 1998-2004  | Britain                     | OLS and 3SLS | Management practices of local firms, horizontal management practices, backward management practices, firm size, size of the company group, human capital, competition pressure, openness to foreign markets and industry dummies | Existence and significance of intra- industry linkage, and inter-industry spillovers of managerial knowledge from foreign to local firms. |
| Karunaratne (2012)     | 1983-2007  | 25 OECD Countries           | Panel cointegration and causality | TFP, FDI inward stocks, FDI outward stocks, openness to trade, R&D expenditure, capital formation and government expenditure, rate of inflation and unemployment | Both inward and outward FDI positively contribute to TFP growth in the OECD. |
| Tang et al. (2012)     | 1987-2004  | China                       | Cointegration and ECM | Consumption, real disposable income, FDI spillover effects (taste and consumption pattern), wealth, real interest and uncertainty | A consumption propensity shift has occurred due to FDI spillover effects. |
| Del Bo (2013)          | 2002-2009  | European Union               | OLS         | TFP, public ownership, horizontal spillover and total assets | In the generation sector, negative vertical spillovers arise only within regional boundaries, but positive horizontal and vertical spillover effects in the distribution sector are distance-related, increasing in magnitude the closer the presence of foreign firms is. |
| Baltabaev (2014)       | 1974-2008  | 49 countries                | GMM         | TFP, distance to the technological frontier, R&D expenditure, human capital, FDI, trade openness, rate of inflation, population growth, and existence of investment promotion agency | FDI is an important factor of technological transfer. |
| Bruhn and Calegario (2014) | 2011     | Brazil                      | OLS and GLM | TFP, capital, labour, qualification, and rate of return on assets, absorptive capacity of industries, technological intensity, FDI, rate of inflation and capital cost | FDI inflows lead to positive spillover effects in high absorption capacity industries and negative effects in labour intensive industries. |
| Merlevede et al. (2014)| 1996-2005  | Romania                     | OLS         | Real output, real capital, number of employees and material inputs | FDI initially negatively affects local competitors’ productivity but then positively impacts later on. |
III. SRI LANKAN ECONOMY: AN OVERVIEW

Sri Lanka, an island located off the southern coast of India in South Asia, has a total area of about 65,610 square kilometres and a total population of 20.9 million people in 2015 (World Bank 2017). At the time of gaining independence from Britain in 1948, Sri Lanka has represented a classic example of the dualistic export economy, which comprised an export-oriented modern plantation economy and a traditional subsistence-oriented agricultural economy (Snodgrass, 1966). During the period between 1948 and 1977, the two distinct phases of government policies that occurred showed that private investment in Sri Lanka responded to changed regulatory conditions. For example, during the second half of the 1960s, there was a partial liberalization that generated better conditions for the private sector. This had a beneficial impact on economic growth, which averaged 5.3 percent per annum during the period 1966–1970. The period 1971–1977 saw a reversal of intensified government intervention and several policy measures that were adverse for private-sector investment. As a result, economic growth sharply decelerated to an annual average of 2.9 percent from 1971–1977.

In 1977, the country’s direction of economic policy changed with the introduction of a market-oriented policy package featuring the deregulation of market activities and the reduction of direct government participation in the economy. Sri Lanka was the first among the South Asian countries to pursue such an open economic policy, targeted to achieving its national development. Trade liberalization began with the removal of quantitative restrictions and licensing requirements for imports and exports, as well as tariff reforms. Such reforms resulted in new incentives for export-oriented foreign investment under an attractive Free Trade Zone scheme. As a result, external market liberalization took place rapidly after 1977, with the removal of exchange controls and the adoption of a floating currency (managed float) in 2001. Sri Lanka has been committed to prudent macroeconomic policies

| Note: Total Factor Productivity (TFP), Ordinary Least Squares (OLS), Weighted Least Squares (WLS), Error Correction Model (ECM), Three Stage Least Squares (3SLS), Generalised Method of Moments (GMM), Generalised Linear Model(GLM), Estimated Generalised Least Squares (EGLS), Dynamic Ordinary Least Squares (DOLS), Two Stage Least Squares (TSLS). |  |  |  |  |
|---|---|---|---|---|
| Lenaerts and Merlevede (2015) | 1996–2005 | Romania | OLS | TFP, FDI, Herfindahl index, firm age and firm size |
| Liu et al. (2016) | 2003–2008 | China | OLS, EGLS and TSLS | Output, number of employees, capital, foreign equity participation, productivity gap, fixed assets, management skills, firm market share, foreign capital share in each province’s electronic industry, MNE’s employment share in each province’s electronic industry, science & technology investment, industry human capital, firm dummy and regional dummy |
| Thang et al. (2016) | 2000–2005 | Vietnam | OLS | TFP, horizontal, backward and forward FDI, economic density, diversification, ratio of urban population of each province, labour quality of each province and competitiveness of the province |
| Zhang (2017) | 2004–2012 | China | OLS | R&D output, number of personnel working in the research sector in province, R&D stock, share of expenses on basic research and experiment research, per capita real GDP in province, absorptive capacity of a province, stock of FDI and time dummies |
| Herzeran Donaubauer (2018) | 1981–2011 | 49 developing countries | Panel cointegration and DOLS | TFP, FDI, GDP, capital, labour, labor share, human capital per worker |

FDI has a positive effect on TFP in the Chinese electronic industry.
Within short distances between foreign and domestic firms, foreign firm presence creates positive spillovers for local firms in supplier sectors (backward spillovers), but negative effect on firms in customer sectors (forward spillovers) and negative effect on firms in the same sector.
FDI contribute positively to the productivity.
FDI has a negative long-run effect on TFP; long-run causality runs in only one direction, from FDI to TFP and in the short run, FDI has a negative effect on FDI.
Only medium sized foreign firms generate spillovers.
and regional integration, joining the World Trade Organization (WTO) in 1995.

Sri Lanka is one of the developing countries that badly needs investment, as its capacity to allocate its funds for development is low due to its lower level of domestic savings (Ravinthirakumaran et al., 2015), which was only 24 percent of its gross domestic product (GDP) in 2015 (World Bank, 2017). To achieve its desired growth, it will require high levels of foreign investment. With these open economic policies, the FDI inflows have started to increase in Sri Lanka. Between 1978 and 2014, FDI inflows have generally increased from $1m to $944m (World Bank, 2017). The investment-favourable policies adopted by the successive governments over the past three decades resulted in FDI inflows into Sri Lanka. Throughout this period, even though there is a general upward trend in FDI inflows to Sri Lanka, there have been sharp falls in certain years (1983, 1989, 1995, 1998 and 2009) due to the civil war.

Providing an attractive business environment has been the basis of Sri Lankan policy since the end of the civil war. Currently, Sri Lanka focuses on long-term strategic and structural development challenges as it strives to transition to an upper-middle-income country. The main challenges to these involve boosting investment, including human capital; realigning public spending and policy with the needs of a middle-income country; enhancing the role of the private sector, including the provision of an appropriate environment for increasing productivity and exports; and ensuring that growth is inclusive (World Bank, 2017). Continued growth depends mainly on fostering private sector development and private investment, especially increased FDI. Through the diversity of mechanisms, including supplier linkages, competition and demonstration effects, as well as labor mobility, FDI spillovers could increase the efficiency, competitiveness, and, ultimately the productive capacity of the domestic economy.

IV. Model Specification

The concept of TFP can be combined with the foreign presence (FDI) of a country. FDI (multinational enterprises) represents the existence of the spillover effect on an aggregate level. To investigate the relationship between FDI and TFP, a model is constructed in which the following variables are included. Then, a country’s TFP level becomes a function of FDI, research and development (R&D), human capital (HC), trade (TRA), technology gap (TGAP), rate of inflation (INF), population growth (POPG) and civil war (WAR). These are the dominant determinants identified in the majority of the studies in Table 1. In our model, this WAR is considered as an exogenous variable. The linear regression framework for determinants of TFP is as follows:

$$ LTFP = \delta_0 + \delta_1 LFDI + \delta_2 LR & D + \delta_3 LHC + \delta_4 LTRA $$

$$ + \delta_5 LGAP + \delta_6 INF + \delta_7 POPG + \delta_8 WAR + \varepsilon $$

(1)

All explanatory variables are in natural logarithm, with the exception of rate of inflation, population growth and war. The $\varepsilon$ is the error term.

The expected signs of the determinants on TFP are as follows: R&D, human capital, trade, and population growth are expected to have a positive effect on TFP, while rate of inflation and dummy variable (civil war) are expected to have a negative effect. The FDI and technology gap could have either positive or negative effects. If FDI inflows bring positive technological externalities to host countries, then FDI positively influences TFP, allowing the host countries to enjoy positive spillovers. However, if FDI inflows bring negative technological externalities to host countries, then they enjoy negative spillovers, implying that FDI could have either positive or negative spillover effects on TFP.

As R & D can be regarded as reflecting an invention in the production process, the development of new products with superior quality improves the TFP. The level of knowledge indicated by human capital plays an important role in TFP. Higher levels of knowledge can help countries increase TFP. Technology transfer, which leads to increased TFP, can take place through international trade, a channel of technological diffusion. The larger technology gap between the home and the host countries will result in lower TFP due to insufficient absorptive capacity. However, if there is sufficient absorptive capacity in the host country, then there may be higher TFP. Since the rate of inflation causes misperception of the relative price levels and leads to inefficient allocation, a higher rate of inflation is associated with lower TFP. A population that has more ideas and innovation helps a society to increase its ability to acquire and use relevant knowledge.

V. Data Sources and Description of the Variables

In the literature of FDI and spillovers reviewed, a majority of studies use firm level data to analyze the spillover effect of FDI. However, due to the limitation of firm level data in Sri Lanka, this study uses aggregate level data to investigate the impact of FDI on TFP. We use annual data over the years from 1978 to 2015 to estimate model (1). TFP is calculated at constant
purchasing power parity rates relative to the US, in terms of the prices in that period. FDI is defined as FDI net inflows in US$. Trade is measured in terms of exports plus imports (US$). Patent applications filed by residents is proxy for R&D. Index of human capital per person for Sri Lanka (annual, not seasonally adjusted) is used as a proxy for human capital. The technology gap is calculated as the ratio of US labor productivity to the labor productivity of Sri Lanka. The labor productivity is measured as per hour labor in US$. The rate of inflation is measured as a GDP deflator (annual %). Population growth is measured as a percentage growth rate of the total population. A dummy variable (WAR) is used to capture the effect of the civil war on TFP during relevant periods. The ‘war’ variable takes the value 1 for the civil war years 1983–2009 and 0 otherwise.

The TFP data are obtained from Penn World Tables PWT 9 (Feenstra et al., 2015). The data for FDI, patent applications, trade, rate of inflation, and population growth are collected from World Development Indicators. The Index of human capital per person is gathered from FRED, Federal Reserve Bank of St. Louis. The data on labor productivity are collected from the Conference Board: Total Economy Database.

VI. Empirical Results and Analysis

a) Unit root tests

First, the time-series properties of these data series are investigated using Augmented Dickey-Fuller (ADF) (Dickey-Fuller, 1979) and Phillips-Perron (PP) (Phillips and Perron, 1988) unit root tests, to avoid the spurious regression estimation results. Table 2 presents the results based on the two unit-root tests. For them, the null hypothesis is that the series has a unit root (i.e., the series is non-stationary). As can be seen, the null hypothesis of a unit root cannot be rejected for all eight variables in their level form, except for three: human capital, rate of inflation, and population growth. However, at the first difference, the null hypothesis of the unit root can be rejected for all five variables. Hence, the results confirm that human capital, rate of inflation and population growth are integrated of order zero, I (0), and all other variables are integrated of order one, I (1).

Table 2: Unit Root Test Results

| Variables | ADF | PP |
|-----------|-----|----|
|           | Levels | First Differences | Levels | First Differences | Order of Integration |
| LTFP      | -0.109 | -3.457*** | -0.182 | -3.422*** | I(1) |
| LFDI      | -1.372 | -5.842*** | -1.517 | -6.025*** | I(1) |
| LR&D      | -0.289 | -8.759*** | -0.576 | -8.525*** | I(1) |
| LHC       | -3.586** | -3.371** | - | - | I(0) |
| LTRADE    | -2.868 | -6.851*** | -2.896 | -7.333*** | I(1) |
| LGAP      | -1.817 | -3.632** | -1.270 | -4.372*** | I(1) |
| INF       | -4.837*** | - | -4.893*** | - | I(0) |
| POPG      | -4.046*** | - | -4.047*** | - | I(0) |

Note: ** and *** indicate statistical significance at the 5 per cent and 1 per cent levels, respectively.

b) ARDL Model and Estimation Results

When there is a linear relationship with time-series variables in which some series are stationary, I(0), and some non-stationary, I(1), it is recommended to use the ARDL bounds test to confirm whether a long-run relationship exists between the model variables. In model (1), the variables human capital, rate of inflation, and population growth are I(0), and the others are I(1). We employ the ARDL bounds test for cointegration, developed by Pesaran et al., (2001), to test cointegration. The ARDL model has some desirable features. First, it can be used regardless of whether the regressors are purely of I(0) or I(1). Second, it estimates the short- and long-run relationships of the model simultaneously. Third, it determines the cointegration relation in small or finite samples (Ravinthirakumaran, 2014; Li and Lin, 2015). The ARDL model is also sufficient to simultaneously correct for residual serial correlation and the problem of endogenous regressors (Pesaran and Shin, 1999). The unrestricted error correction model for the ARDL representation can be written as:

\[
\Delta LTFP_t = \beta_0 + \beta_1 LTFP_{t-1} + \beta_2 LFDI_{t-1} + \beta_3 LR & D_{t-1} + \beta_4 LHC_{t-1} + \beta_5 LTRA_{t-1} + \beta_6 LGAP_{t-1} + \\
+ \beta_7 INF_{t-1} + \beta_8 POPG_{t-1} + \beta_9 WAR_{t-1} + \sum_{i=1}^{f} \alpha_i \Delta LTFP_{t-i} + \sum_{i=0}^{g} \alpha_{2i} \Delta LFDI_{t-i}
\]
Where $\Delta$ is the first difference operator, $\beta_i$ is the drift component, and $\epsilon$ is the white noise residuals. The coefficients $(\beta_1, \beta_2, \ldots, \beta_9)$ represent the long-run relationship, whereas the remaining coefficients with the summation sign $(\alpha_0, \alpha_1, \ldots, \alpha_9)$ represent the short-run dynamics of the model. The structural lags $f, g, h, i, j, k, l, m$ and $n$ are determined by using the minimum Akaike Information Criterion (AIC). The bound test is conducted in order to investigate the existence of the long-run relationship among the variables in the system. The bound test, based on the F-statistic for the joint significance of the coefficients $(\beta_1, \beta_2, \ldots, \beta_9)$, follows a non-standard distribution. Under this, the null hypothesis of no cointegration is tested against the alternative of cointegration.

$$H_0: \beta_1=\beta_2=\beta_3=\beta_4=\beta_5=\beta_6=\beta_7=\beta_8=\beta_9=0$$

$$H_1: \text{At least one } \beta_i \neq 0, i = 1, 2, \ldots, 9$$

The two sets of critical values are I(0) and I(1) (Pesaran et al., 2001). If the calculated F statistic falls below the lower bound I(0), the null hypothesis $H_0$ cannot be rejected, which means that no cointegration exists among the nine variables. In contrast, if the F statistic is above the upper bound I(1), $H_0$ should be rejected, meaning that a cointegration relationship exists among the nine variables in the longrun. If the F statistic lies between I(0) and I(1) as bounds, the inference is inconclusive.

The calculated value of the F-statistic to test the above null hypothesis is 4.79, which is greater than the upper critical bound values in Pesaran et al., 2001, which in Table C1 (iii) Case III) are at the 1 percent [2.96, 4.26], 5 percent [2.32, 3.50] and 10 percent [2.03, 3.13] levels of significance. Therefore, it can be concluded that cointegration exists among the variables considered. That is, a long-run relationship exists between TFP and the eight variables in model (1). Also, the F-statistic 4.79 is compared with the finite-sample critical values (provided by Narayan (2005), Table: Case III, for $T = 38$) to see whether the conclusions remain the same. The results also reveal that there exists a long-run relationship among the variables, since the calculated value of the test statistic is greater than the upper bound values at 5 percent (2.75, 4.21) and 10 percent (2.30, 3.61) significant levels.

Since the cointegration between TFP and other variables is found, the long-run model (1) has been estimated. The estimated coefficients for the model are given in Table 3. As can be seen, in the longrun, the estimated coefficient for the FDI is positive and statistically significant at the 10 percent level, implying that FDI is one of the factors that influence TFP. This infers that there are positive spillovers from FDI in the Sri Lankan economy. A similar finding is reported in several studies, such as those of Piyaareekul and Peridy (2010), Karunaratne (2012), and Baltabaev (2014). R & D contributes positively to TFP and is statistically significant at the 1 percent level, confirming that R&D plays a significant, and positive role in determining TFP growth. This finding about R & D is also in line with the results reported by Romer (1990), Jones (1995) and Baltabaev (2014). The coefficient of human capital is also positive and significant at the 5 percent level, indicating that human capital plays an important role in determining TFP. This result is also similar to the findings of Kneller (2005) and Baltabaev (2014).

The trade coefficient is positive and significant at the 1 percent level. It thus has a positive effect on TFP, which confirms that international trade in goods and services leads to an increasing accumulation of knowledge that can increase TFP. This result is comparable with the results reported in Keller (2004) and Baltabaev (2014). The coefficient corresponding variable TGAP is negative, indicating that the technology gap negatively affects on TFP and is estimated significantly at the 1 percent level. This implies that a large technology gap tends to reduce TFP due to a lack of absorbing capability. The result about the technology gap is consistent with the study by Kokko et al. (1996). The inflation is negative and statistically significant at the 1 percent level, suggesting that a higher rate of inflation is associated with lower TFP. The finding is line with the result reported by Baltabaev (2014). However, population growth is positive and statistically insignificant, suggesting that the population growth has no significant effect on the TFP. This may be because the population is poorly trained, which fails to help society to increase TFP. The WAR variable coefficient is negative and significant, indicating that civil war adversely influences the TFP.
Table 3: Estimated Long-run Coefficients of the ARDL Model

| Regressor | Parameter | Coefficient | Standard Error | p-value |
|-----------|-----------|-------------|----------------|---------|
| LFDI      | $\delta_1$ | 0.026       | 0.014          | 0.060   |
| LR&D      | $\delta_2$ | 0.191       | 0.037          | 0.001** |
| LHC       | $\delta_3$ | 0.429       | 0.171          | 0.023   |
| LTRA      | $\delta_4$ | 0.120       | 0.040          | 0.009** |
| LTGAP     | $\delta_5$ | -0.482      | 0.066          | 0.000** |
| INF       | $\delta_6$ | -0.004      | 0.001          | 0.003** |
| POPG      | $\delta_7$ | 0.045       | 0.027          | 0.112   |
| C         | $\delta_8$ | 3.655       | 0.890          | 0.001***|
| WAR       | $\delta_9$ | -0.028      | 0.012          | 0.026** |

Note: *, ** and *** indicate statistical significance at the 10 per cent, 5 per cent and 1 per cent levels, respectively.

To estimate the short-run dynamic parameters, we use an error correction model of the form:

$$
\Delta \text{LTFP}_t = \alpha_{10} + \sum_{i=1}^{k} \alpha_{1i} \Delta \text{LTFP}_{t-i} + \sum_{i=0}^{k} \alpha_{2i} \Delta \text{LFDI}_{t-i} + \sum_{i=0}^{k} \alpha_{3i} \Delta \text{LR&D}_{t-i} + \sum_{i=0}^{k} \alpha_{4i} \Delta \text{LHC}_{t-i} + \sum_{i=0}^{k} \alpha_{5i} \Delta \text{LTRA}_{t-i} + \sum_{i=0}^{k} \alpha_{6i} \Delta \text{LTGAP}_{t-i} + \sum_{i=0}^{k} \alpha_{7i} \Delta \text{INF}_{t-i} + \sum_{i=0}^{k} \alpha_{8i} \Delta \text{POPG}_{t-i} + \sum_{i=0}^{k} \alpha_{9i} \Delta \text{WAR}_{t-i} + \lambda \text{ECT}_{t-1} + \varepsilon_t
$$

(3)

where $\alpha_i (i=1, 2, ..., 9)$ are the short-run dynamic coefficients, $\lambda$ is the speed of the adjustment parameter, and ECT is the error correction term that is calculated from the estimated model (1) in the following form:

$$
\text{ECT} = \text{LTFP} - \delta_6 \text{LFDI} - \delta_7 \text{LR&D} - \delta_8 \text{LHC} - \delta_9 \text{LTRA} - \delta_5 \text{LTGAP} - \delta_3 \text{INF} - \delta_4 \text{POPG} - \delta_2 \text{WAR}
$$

(4)

The ARDL (2, 1, 0, 1, 2, 2, 2, 1) is selected based on AIC, and the results of the short-run dynamic coefficients associated with the long-run relationships are shown in Table 4. The equilibrium error correction coefficient ECT is -0.53, which has the expected negative sign and is significant at the 1 percent level.

Table 4: Estimates of the Error Correction Model

| Regressor     | Parameter | Coefficient | Standard Error | p-value |
|---------------|-----------|-------------|----------------|---------|
| $\Delta \text{LTFP}(-1)$ | $\alpha_{10}$ | 0.412       | 0.114          | 0.0002   |
| $\Delta \text{LFDI}$ | $\alpha_{20}$ | 0.024       | 0.010          | 0.031    |
| $\Delta \text{LR&D}$ | $\alpha_{30}$ | 0.064       | 0.012          | 0.000    |
| $\Delta \text{LHC}$ | $\alpha_{40}$ | 1.580       | 0.649          | 0.023    |
| $\Delta \text{LTRA}$ | $\alpha_{50}$ | 0.055       | 0.029          | 0.072    |
| $\Delta \text{LTRA}(-1)$ | $\alpha_{51}$ | 0.044       | 0.024          | 0.082    |
| $\Delta \text{LTGAP}$ | $\alpha_{60}$ | -0.284      | 0.057          | 0.000    |
| $\Delta \text{LTGAP}(-1)$ | $\alpha_{61}$ | 0.091       | 0.055          | 0.108    |
| $\Delta \text{INF}$ | $\alpha_{70}$ | -0.001      | 0.000          | 0.000    |
| $\Delta \text{INF}(-1)$ | $\alpha_{71}$ | 0.000       | 0.000          | 0.096    |
| $\Delta \text{POPG}$ | $\alpha_{80}$ | 0.000       | 0.007          | 0.908    |
| $\Delta \text{WAR}$ | $\alpha_{90}$ | -0.015      | 0.007          | 0.072    |
| $\text{ECM}(-1)$ | $\lambda$ | -0.532***   | 0.148          | 0.0002   |

Note: *** indicate statistical significance at the 1 per cent level.
Diagnostic Tests
To check whether the estimated results are reliable, three diagnostic tests are employed: serial correlation, functional form, and heteroscedasticity. The results given in Table 5 reveals that residuals are serially uncorrelated, normally distributed and homoscedastic at the 5 percent level of significance and have a correct functional form. Therefore, there is no evidence of a diagnostic problem with the model.

| Tests                  | F-Statistic | p-value |
|------------------------|-------------|---------|
| Serial Correlation(a)  | 0.366       | 0.554   |
| Functional Form(b)     | 1.482       | 0.242   |
| Normality(c)           | 0.215       | 0.898   |
| Heteroscedasticity(d)  | 0.143       | 0.708   |

Note: Null hypothesis in a = No serial correlation; b = Functional specification is correct, c = Residuals are normal, and d = Residuals are homoscedastic.

Stability Tests
In the final stage, the cumulative sum (CUSUM) and the CUSUM of square (CUSUMSQ) tests have been used to examine the stability of the long-run coefficients. The graphical presentation of these tests is shown in Fig.1. Since the plots of the CUSUM and CUSUMSQ statistics are within the critical lines at the 5 percent significance level, there exists stability in the parameters and error terms of the estimated model over the sample period.

VII. Conclusions and Policy Implications
This study has examined the spillover effects of FDI in Sri Lanka by using time-series data for the period 1978–2015. The review of previous research identified seven important determinants that generally determine total factor productivity: FDI, R&D, human capital, trade, technology gap, rate of inflation, and population growth. We have also included a dummy variable (WAR) to analyze the effect of the civil war on TFP. The estimated results suggest that there is a long-run relationship among the variables considered. FDI has a positive effect on total factor productivity, indicating that FDI is one of the important determinants of TFP. Thus, FDI brings positive spillovers into the Sri Lankan economy.

R & D has a positive effect on TFP, meaning that a larger amount of R & D facilities leads to higher total factor productivity. Therefore, increasing the level of R&D facilities is necessary for Sri Lanka to maintain sustainable total factor productivity. Human capital has a positive effect on total factor productivity, suggesting that increasing investment in human capital leads towards technical and/or labor efficiency. International trade also positively influences total factor productivity in Sri Lanka. This implies that implementing greater trade liberalization policies enhances international trade,
which increases total factor productivity. The technology gap in Sri Lanka has a negative impact on total factor productivity, revealing that it is necessary to increase the ability for absorption in order to reduce the technology gap. As the rate of inflation negatively affects productivity, Sri Lankan government intervention is necessary to eliminate the inflationary environment.

Population growth does not have an effect on total factor productivity. This indicates that increasing the size of the workforce with more innovative ideas is crucial for Sri Lanka, to increase the total factor productivity, as a well-educated population has a greater ability to create new technologies. In addition, the civilwar in Sri Lanka had a negative impact on total factor productivity, implying that civil war is associated with greater uncertainty regarding future economic policy and does adversely affect productivity. The findings of the analysis confirm that encouraging FDI inflows into Sri Lanka should be expected to have a beneficial effect on total factor productivity. The results thus support the argument of the positive spillover effects of FDI. The conclusion from this study gives practical suggestions for promoting FDI and for introducing policies to attract FDI in flows in developing countries, particularly countries like Sri Lanka.

**Disclosure statement**

No potential conflict of interest was reported by the authors.

**Notes**

Before estimating the model, we checked the correlation among the explanatory variables and found that multicollinearity does not seem to be an issue with this data. In order to conserve space, we did not provide the correlation matrix of explanatory variables but it is available upon request.

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