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The Long-run Effect of Services Exports on Total Factor Productivity Growth in Sri Lanka: Based on ARDL, FMOLS, CCR, and DOLS Approaches

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Abstract

This research paper investigates the importance of services exports (SEXP) on total factor productivity (TFP) growth in Sri Lanka analyzing time series data from 1984 to 2013. The study employs a range of econometric models, namely Johansen cointegration (JJ) test, autoregressive distributed lag model (ARDL), fully modified least squares method (FMOLS), canonical cointegration regression (CCR) and dynamic ordinary least squares method (DOLS), and come up with a more robust result. The main finding is that SEXP, gross capital formation (GCF), and labor force (LF) significantly influence to promote TFP in the long-run in Sri Lanka. The result is stable and robust as all the models yield consistency result. The long-run coefficient of SEXP ranges between 0.026121 (JJ), and 0.101286 (ARDL). Hence, proper policy formulation to encourage SEXP could be of vital to reap economic benefits via enhancing the productivity in the overall economy as the export market provides more space for growth, against the quickly exhaustible domestic demand for services in Sri Lanka.

Keywords: Sri Lanka, ARDL, DOLS, FMOLS, Services Exports.

Introduction

This study makes an effort to examine the long-run relationship between SEXP and TFP growth in Sri Lanka. Unlike to the available literature in Sri Lanka as well as in econometric literature, this paper focuses and analyzes the effect of SEXP on TFP growth. In theoretical literature, Export-productivity growth relationship has been built considering the aggregate level of exports rather than disaggregates. There is no prior reason to deny it theoretically. However, available empirical literature has drawn different results analyzing the effect of more disaggregate level exports on productivity against the aggregate level exports. Either goods exports or SEXP, the relationship as mentioned above, assumes that exports are a major factor that contributes to enhancing the productivity. From the supply side perspectives, exports promote economic growth, increasing the efficiency due to re-allocation of resources, economies of scale through large-scale operations, increased competition and the introduction of efficient

management styles (Chuang, 1998; Kunst & Marin, 1989). From the demand side, unlikely to the quickly exhaustible domestic market, the international market provides more growth space for exporters stimulating the economic growth (Agosin, 1999).

The other group of researchers, however, argue that exports promote economic growth does not necessarily hold for developing countries (Debnath, Laskar, Bhattacharjee, & Mazmuder, 2014). Their first argument is based on the composition of exports rather than aggregate level exports. Herzer (2007) argued that unlike to the manufacturing exports (MEX), the primary exports (PEX) do not link with the rest of the economy in multiple ways, hence do not have a positive spillover effect. Therefore, it is unlikely to generate sustainable economic growth. On the other hand, PEX is more vulnerable in the international market, therefore, faced with price volatility in the global market causing the volume volatility (Debnath, Laskar, et al., 2014). Hence, high dependence on PEX may lead to increase the volatility in GDP as well as macroeconomic uncertainty volatility (Debnath, Laskar, et al., 2014). The second argument opposing exports promote economic growth is that adoption capacity of non-exporting sectors. The evidence by Edwards (1993) shows that shock of the technology from export market is subject to the level of given technology and human capital of domestic as well as exporting firms. Further, the expansion of exports in a situation where the factor market is imperfect may cause unemployment and productivity loss (Edwards, 1993). These theoretical explanations show that exports promote economic growth depends on the structure and composition of the exports, the absorption capacity of non-exporting, as well as exporting sectors and the factor market structure (Debnath, Laskar, et al., 2014).

Based on aforementioned theoretical base, the empirical literature has continuously discussed the relationship between exports and productivity. Despite the methodology used by previous empirical research on this relationship, they have made a significant contribution for understanding the relationship between exports and productivity in general. A closer look at the previous empirical works on exports, and productivity relationship shows two significant developments.

The first is development in econometric methodology. The most of the early investigations have relied on the cross-sectional analysis, however; major criticism was that the assumption of common economic structure and differences in estimated parameters across countries. The possibility of getting time series data has directed the assessment of exports-productivity relationship towards time series analysis overcoming the shortcomings of the cross-sectional studies. Many researchers have documented the pros and cons of cross-sectional and time series analysis and will not be repeated here.

The second is development in defining of exports. Regarding the definition of the exports, previous studies can be categorized into two branches such as analysis with (a) aggregate exports and (b) components of exports. The focus of this study is to contribute to the second branch of literature (exports components and productivity), however, before proceeding, it is worth to discuss the limitation of parameters obtained from aggregate level exports on productivity growth. Analyzing the relationship between total or aggregate exports (TEX) and productivity is good enough to understand and proves the theoretical relationship between the two variables. However, the parameters obtained from such an analysis may not equally hold for major components of exports. In other words, the coefficients of different components of exports on productivity possibly may be different in sign and magnitude. For example, substantial proportion

of exports in the TEX may dominantly determine the coefficient obtained from analyzing TEX. Furthermore, some components of exports may have a statistically significant contribution to promoting productivity while others may not have. Given such a dynamic and complex relationship, and as per the policy formulation is concerned, disaggregate parameters are important than the aggregates.

The above limitations motivated some researchers to investigate exports-productivity relationship using more disaggregated level exports. Few of them are briefly discussed here, so that easy to understand the importance of the phenomena. Kavoussi (1984) differentiated the effect of TEX, manufacturing exports (MANUX) and PEX on the growth of TFP in 72 developing countries. The study found that PEX enhances the TFP in low-income countries while MANUX improves the TFP in middle-income countries. Further, the export-TFP relationship in more advanced developing countries is very sensitive to the share of MANUX to TEX. Another study by Herzer, Nowak-LehmannD, and Siliverstovs (2006) examined the effect of MANUX and PEX on the growth of TFP in Chile. The authors concluded that the growth of MANUX enhances the TFP while the PEX limits the productivity. The finding of this author relating to the PEX is different from Kavoussi (1984). These two studies itself sufficient to understand the parametric differences relating to the components of exports, which is crucial for policy formulation is concerned.

Above discussion, shows that empirical investigations have made an effort to establish exports-productivity growth relationship theoretically and empirically while focusing and accounting the developments, which have brought to international trade. One of the recent development in the international trade is that SEXP has become an essential part as the counterpart to the manufacturing exports. However, this development has rarely been accounted so far.

Following the introductory section, this paper is organized as follows. Section 2 provides a brief background to the SEXP both in global and Sri Lankan context. Section 3 briefly reviews previous empirical works related to the SEXP and productivity growth/economic growth. Section 4 highlights the motivation and the contribution. Section 5 constructs the empirical model. Section 6 discusses the data sources, treatment to the data and econometric methodology. Section 7 presents the empirical results. Section 8 devotes for discussion about the estimated long-run parameters. Section 9 concludes the paper.

Background

Presently, the service sector has become the dominant part of GDP regardless of developed or developing countries. The development experience of advanced economies shows that the contribution of service sector can go even beyond the three fourth of an economy. For instance, services sector in the United States accounts for over 70% of GNP while employing 80% of the workforce. According to Javalgi and White (2002), services GDP is close to two-thirds of world output and almost double than that of manufacturing, and therefore there is an incredible scope of services globalization. The upturn in the service sector in the domestic economy around the world influences on international trade too. In 2014, SEXP stood at US\$3 trillion (UNCTAD, 2015). Javalgi and White (2002) pointed out that services trade in the global market performed better than merchandise exports (MERX) because of the growth of former was faster than the later in the 1990s. Samiee (1999) showed that the contribution of services trade accounted for one-fourth of global merchandise trade in 1995 and it has been increasing at a double-digit

growth rate. Ghani (2010) showed that SEXP from developing countries has remarkably grown in the last ten years.

As in other economies in the world, Sri Lanka also has gradually transformed towards a services-based economy. In 1950, the GDP share of services sector was 36.9%, and it increased to more than half (50.1%) of GDP by 1994 (CBSL, n.d). In 2015, the share of the services sector to Sri Lanka's economy was about 56.3% of GDP (CBSL, n.d). The transformation in Sri Lankan economy into service sector also occurred in the labor market, occupying about 45% of the workforce. Sri Lanka's SEXP stands at 7% of GDP by 2013. SEXP of Sri Lanka shows a better performance than goods exports in the global market. During the period from 2000 to 2015, Sri Lanka's share of merchandise exports (MREX) in the world market declined by 24.6% while the percentage of SEXP rapidly increased by 114.9% (Athukorala, Ginting, Hill, & Kumar, 2017). During the study period (1984-2013), the average contribution of SEXP to TEX in Sri Lanka accounted for 19.77%. Sri Lanka has long experienced widening the deficit of current account because of increasing the deficit from goods trade. However, the surplus of services trade is one of the major sources that offset the deficit to some extent. Therefore, the growing importance of SEXP is important to diversify the export base of Sri Lanka.

Literature Review

Few authors have made their efforts to incorporate SEXP in exports-economic growth/productivity growth analysis. The important facts of these empirical works such as econometric methodology, data, and main findings are briefly discussed below.

The novel work by Gabriele (2006) has been attempted to differentiate the effect of SEXP from mechanize exports on economic growth in different groups of countries and in different time periods in a sample of 114 countries. The analysis further continued with six sub-divided groups of countries such as (1) developed countries, (2) Latin American countries, (3) Africa, (4) Near East and Mediterranean countries, (5) East Asia and Pacific and (6) Transition Economies. The data covered from 1980 to 2000 while the analysis went through sub-periods of 1980-1990 and 1990-2000 along with full sample period (1980-2000). The basic econometric model has been constructed taking the growth rate of SEXP and the MREX as independent variables. However, the study has maintained the robustness of results by adding two other growth factors, i.e., investment/GDP ratio and initial per capita GDP of countries. The study found a positive and significant impact of SEXP on economic growth in developing countries; however, the nexus was weaker than developed countries. Further, based on the sub-period analysis, the author showed the effect of exports on growth as a whole, had been declined; however, the decline was mainly due to MREX rather than SEXP did. This finding confirms the need for investigating the effect of exports on economic growth using more disaggregate level exports rather than aggregate exports regarding right policy formulation.

The work by Dash and Parida (2012) examined the role of both SEXP and services imports on economic growth in India. The data analysis of the study was focused on the post-reform period in India, and used quarterly data from Q1:1996-1997 to Q1:2010-2011. The econometric model was constructed using four variables namely exports and imports of services, GDP, and real exchange rate. As per the econometric methodology is concerned, the authors employed autoregressive distributed lag model (ARDL), vector error correction model (VECM), Granger causality and impulse response analysis. The study found long-run equilibrium relationship

between the variables. As per the SEXP-economic growth relationship is concerned, the study established services export-led growth hypothesis. These authors addressed the possible endogenous problem in the model by defining SEXP netting out of GDP.

Debnath, Laskar, et al. (2014) explored the productivity effect of exports on non-export GDP in India for the period from 1981 to 2012. The Neoclassical production function was augmented with four variables, i.e., non-export GDP, capital, employment, and exports. The analysis went through defining exports in three different ways such as TEX, MREX, and SEXP. The purpose of such decompositions was to identify the different productivity effect of disaggregate level exports on economic growth. The analysis of ARDL bound test confirmed the presence integration of each category of exports (total, merchandise, and services) with non-exports GDP, capital, and employment. However, the study was unable to find any significant evidence for TEX enhancing TFP in the long-run, instead found a positive and significant relationship concerning to SEXP.

A similar study by Debnath, Roy, Dasgupta, and Mazumder (2014) examined the differences in productivity effect of export composition on the non-exporting sector from 1988 to 2012. This study built a basic econometric model with five variables namely non-export GDP, capital, labor, capital goods imports, and exports (TEX). The study further extends the analysis by decomposing TEX into MREX and SEXP, and later, MERX into three categories such as PEX, MANUX, and petroleum exports to examine the productivity differentials from such decomposition. In the data analysis, the study employed ARDL framework. The findings of this study indicated TEX did not promote TFP while it was found different productivity effect of components of exports on non-export GDP. To further explained, SEXP had a positive spillover effect while MERX, as a whole, did not have such effect. The authors, further digging the MREX, found that PEX (significant) and oil exports (insignificant) had a negative impact while MANUX had a positive and significant effect on non-export GDP. This study also further confirmed the validity of more disaggregate level exports in exploring the export-productivity growth relationship.

Motivation and Contribution of the Study

The service sector has become the largest sector of Sri Lanka's economy that contributes for more than half of GDP and absorbs a significant portion of the labor force. In short, more than 50% of economic products of Sri Lanka is services. The most important fact is that now service GDP has become tradable, particularly, services can be produced and exported at low cost (Ghani, 2010). SEXP accounted for about 7% of Sri Lanka's GDP in 2013. Meantime, mixed results yielded in previous studies, motivated some researchers to investigate the export-economic growth relationship using disaggregate level exports (Herzer et al., 2006; Kavoussi, 1984). Debnath, Roy, et al. (2014) and Debnath, Laskar, et al. (2014) found positive spillover effect of SEXP on TFP while they failed to find such relationship in the case of TEX. In this context, it is essential to investigate the relationship between SEXP and TFP growth. Few attempts so far, have made to analyze the importance of SEXP in the TFP. It is pertinent to mention that limited available literature on SEXP is not sufficient for a more profound understanding of the relationship between SEXP and TFP growth. Analysis of exports disaggregating services will provide insights about the magnitude that SEXP contributes to the overall economic growth via TFP. Therefore, this study motivates to find the importance of SEXP on TFP.

As far as the novelty of this paper is concerned, among few studies that have made to identify the significance and the nature of SEX- TFP/economic growth relationship, no such study to examine if and how SEXP influence TFP growth in Sri Lanka. To this respect, the primary purpose of this study is to consider the effect of the growth of SEXP on the growth of TFP in Sri Lanka. Moreover, rather than relying on a single econometric procedure, this study employs a range of time series data analyzing techniques such as ARDL, FMOLS, CCR and DOLS and draws more robust results.

Empirical Model

Considering the above-mentioned theoretical relationship, this study starts with neoclassical production function as follows to investigate the effect of SEXP on economic growth via the growth of TFP (Herzer et al., 2006).

$$Y_t = A_t K_t^\alpha L_t^\beta \quad (1)$$

Equation (1) is the neoclassical form of aggregate production function of the economy at time t. The term A_t represents the TFP of the economy. K_t is the capital and L_t is the labor force. To find the effect of SEXP on TFP, A_t can be expressed as a function of SEXP and other exogenous factors as follow.

$$\begin{aligned} A_t &= f(SEXP_t, T_t) \\ &= SEXP_t^\rho T_t \end{aligned} \quad (2)$$

Where $SEXP_t$ and T_t denote services exports and other exogenous factors that can influence the TFP respectively. Substituting the equation (2) into equation (1), the model (3) can be built as follows.

$$Y_t = T_t K_t^\alpha L_t^\beta SEXP_t^\rho \quad (3)$$

Converting the equation (3) into the natural log gives the following linear model.

$$\ln Y_t = c + \alpha \ln K_t + \beta \ln L_t + \rho \ln SEXP_t + e_t \quad (4)$$

In equation (4), α, β , and ρ are elasticities of production corresponding to the K, L, and SEXP respectively. The term c is the constant of the model and e_t in the error term. The prime objective is to estimate of ρ which will serve as the productivity effect of SEXP. The positive and significant estimate of ρ implies the growth of SEXP on the growth of TFP.

Data and Econometric Methodology

Data Sources and Treatment

Four variables are used in the analysis. They are per capita GDP (PCGDP) (USD), per capita gross capital formation (GCF) (mn. USD), LF (number) and SEXP (mn. USD). Many authors argue that according to the national account identity, export itself is a part of GDP; hence, there may always be a positive relationship with GDP regardless of its actual relationship. To remedy this problem, PCGDP is used as the dependent variable. SEXP is deflated by GDP deflator and express

in real terms. Data sources are UNCTAD, World Development Indicators (WDI) and ADB key statistics.

Econometric Methodology

Unit Root Test

This study used time series data. Generally, time series data show trending behavior (scholastic trend), in other words, there may be a problem of none stationarity. It is necessary to remove such trending behavior to obtained valid results. Hence, it is a pre-condition to test time series properties to identify whether the variable is stationary at levels, first difference or second difference. These results of unit root test will help to select the appropriate econometric method for the data analysis. There are numbers of unit root tests in econometric literature. Of them, this study uses augmented Dicky- Fuller unit root test (ADF)(Dickey & Fuller, 1979) and Philips Perron (PP) unit root test (Phillips & Perron, 1988), which are widely applied in econometric literature.

$$\Delta z_t = \delta_0 + \delta_1 Z_{t-1} + \sum_{i=1}^k \alpha_i \Delta Z_{t-i} + \mu_t \quad (5)$$

$$\Delta z_t = \delta_0 + \delta_1 t + \delta_2 Z_{t-1} + \sum_{i=1}^k \alpha_i \Delta Z_{t-i} + \mu_t \quad (6)$$

The ADF test is performed both with and without time trend in this study. The equation (5) is with constant and no trend while the equation (6) is with constant and time trend (Agiakloglou & Newbold, 1992; Cheung & Lai, 1995; Dritsakis, 2004). The ADF regression of the equation (5) and (6) test the presence of unit root of Z_t . The term “t” and “k” refer to the time and numbers of lags included in the unit root testing regression. ΔZ_{t-i} refers to the first difference of the variable with k lags. The term μ_t adjusts the errors of autocorrelation. The parameters α_i , δ_0 , δ_1 , and δ_2 are estimated. The null hypothesis of H_0 : “ Z_t has a unit root” against the alternative hypothesis of H_A : “ Z_t is stationary” in the equation (5) is tested as follows (Dritsakis, 2004).

$$H_0: \delta_1=0 \quad H_A: \delta_1 < 0$$

The null hypothesis of H_0 : “ Z_t has a unit root” against the alternative hypothesis of H_A : “ Z_t is stationary” in the equation (6) is tested as follows (Dritsakis, 2004).

$$H_0: \delta_2=0 \quad H_A: \delta_2 < 0$$

In the cointegration test, ARDL bound test for cointegration, JJ, and Engle-Granger (EG) residual-based cointegration tests were performed as discussed below.

ARDL Bound Test for Cointegration

This study employs the ARDL model developed by Pesaran, Shin, and Smith (2001) to investigate the relationship between SEXP and TFP growth in Sri Lanka. The ARDL model provides two bounds of critical values; one is when the variables are purely $I(0)$, and the other is when the variables are purely $I(1)$. Therefore, ARDL model avoids the shortcomings arising the classification of variables according to their order of integration as $I(0)$ or $I(1)$. In another word, the ARDL

model is possible to apply whether the series is purely $I(0)$ or purely $I(1)$ or combination of both. Many authors have claimed the merits of ARDL model against traditional cointegration tests. Alam and Quazi (2003) pointed out that the ARDAL model is applicable even with the endogenous problem of explanatory variables. Further, unlike to the EG technique, ARDL model can be used to explore short-run dynamics along with the long-run relationship (Pattichis, 1999). Poon (2014) showed that estimated unrestricted error correction model is adequate only when the model satisfies the assumption of the classical linear model. There are series of diagnostic tests in the ARDL model to confirm whether the estimated error correction model satisfies these assumptions as follows. (1) Lagrange Multiplier test to test whether the residuals are serially correlated or not. (2) Heteroscedasticity test and autoregressive conditional heteroscedasticity (ARCH) test to find whether the estimated model is heteroscedastic or homoscedastic. (3) Jurque-Bera test for residual normality. (4) Ramsey RESET test for functional form and misspecification problem. (5) CUSUM test and CUSUM or squares test for parameter stability over the period. The unrestricted error correction representation of the ARDL model for equation (4) is presented as follows (Dritsakia & Stiakakis, 2014; Paul, 2014; Poon, 2014).

$$\begin{aligned} \Delta y_t = & \alpha_0 + \beta_1 y_{t-1} + \beta_2 K_{t-1} + \beta_3 LF_{t-1} + \beta_4 SEXP_{t-1} + \sum_{i=1}^p \delta_{1i} \Delta y_{t-i} + \sum_{i=0}^p \delta_{2i} \Delta K_{t-i} \\ & + \sum_{i=0}^p \delta_{3i} \Delta LF_{t-i} + \sum_{i=0}^p \delta_{4i} \Delta SEXP_{t-i} \\ & + \varepsilon_t \end{aligned} \quad (7)$$

where Δ is the difference operator, p is the lag length, ε_t is the random error term. y_t represents PCGDP. The cointegration between PCGDP, GCF, LF, and SEXP can be tested for H_0 of “no cointegration” by imposing restrictions on the joint significance of parameters as $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ against the $H_1: \beta_1 \neq 0, \beta_2 \neq 0, \beta_3 \neq 0, \beta_4 \neq 0$. The null hypothesis can be tested through computing F-statistics and comparing it against the lower and the upper bounds critical values of Pesaran (2001). If the F-statistic > upper bound critical value at 5% level then, the H_0 is rejected. It implies there is a long-run relationship between targeted variables. If the F-statistic < lower bound critical value, which means there is no long-run relationship. Finally, if the F-statistic lies between the lower bound and the upper bound critical values, the inference is inconclusive. While employing ARDL model, standard cointegration technique, i.e., Engle and Granger (1987) residual-based cointegration test, and Johansen (1988) and Johansen and Juselius (1990) cointegration (JJ) test also are performed to reaffirm the results obtained from the ARDL model.

Johansen Cointegration Test

The equation for the JJ test in a VAR model can be written as follows. In equation (8) ϕ is the vector ($P \times 1$) of constant terms, Δ is the difference operator, Z_t is the $P \times 1$ vector of variables in the model, Γ is the coefficient matrix [$\Gamma_i = -I + A_1 + A_2 + \dots + A_i$ ($i=1, 2, \dots, P-1$)]. μ_t is the vector ($P \times 1$) of disturbance term. Π is the ($P \times P$) coefficients matrix [$\Pi = I - A_1 - A_2 - \dots - A_P$]. The matrix of Π shows the long-run relationship between Z_t variables while the rank of Π means the number of linearly dependent and stationery linear combinations of variables (Dritsakis, 2004).

$$\Delta Z_t = \phi + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \dots + \Gamma_{p-1} \Delta Z_{t-p+1} + \Pi Z_{t-1} + \mu_t \quad (8)$$

As proposed by Johansen (1988) and Johansen and Juselius (1990), there are two test statistics for testing the number of cointegrating vectors (CVs) (or the rank of Π) in the VAR model. The first is trace test (Tr). In trace test, the H_0 is that "there is at most r CVs which implies the number of CVs is less than or equal to r , ($r=0, 1, 2, 3, \dots$) (Dritsakis, 2004; Khalafalla & Webb, 2001). The second test statistic is Maximum-Eigen values test (*L-max*). Under the Maximum-Eigen value, the presence of r CVs can be tested against the H_1 of $r+1$ CVs. Therefore, H_0 for testing numbers of CVs can be set as $H_0 : r = 0$ against the $H_A: r=1$, $H_0 : r = 1$ against the $H_A: r = 2$, $H_0 : r = 2$ against the $H_A: r = 3$ and so forth (Dritsakis, 2004; Khalafalla & Webb, 2001).

Engle and Granger Cointegration Test

EG residual-based cointegration also is performed. The equation (4) is estimated using OLS and tested the residual series for stationarity using ADF test. The H_0 : is that "residual series ($\hat{\epsilon}_t$) obtained from equation (4) are $I(1)$ against the H_A : "estimated residual are $I(0)$ ". The test statistic is compared with critical values from the table 3 of MacKinnon (2010) concerning to $k=4$. If the residuals of estimated model are stationary, the model (4) is a long-run model. The ADF t-statistic is estimated as in the following equation (9) (Herzer & Nowak-LehmannD, 2006).

$$\Delta \hat{\epsilon}_t = \rho \hat{\epsilon}_{t-1} + \sum_{j=1}^k \beta_j \Delta \hat{\epsilon}_{t-j} + V_t \quad (9)$$

This study also performs FMOLS, CCR, and DOLS to reaffirm the results obtained in the ARDL model.

The FMOLS Estimates

It is important to test the sensitivity of long-run parameters obtained from ARDL, before concluding the study. This analysis re-estimates the model (4) employing FMOLS developed by Phillips and Hansen (1990), CCR by Park (1992) and DOLS developed by Stock and Watson (1993) to find the robustness of the estimates. FMOLS adopts the semi-parametric approach in estimating the long-run parameters (Adom, Amakye, Barnor, & Quartey, 2015; Fereidouni, Almulalia, & Mohammed, 2014). This technique gives consistent parameters even in the small sample size and overcomes the problems of endogeneity, serial correlation, omitted variable bias, measurement errors and allows for the heterogeneity in the long-run parameters (Agbola, 2013; Bashier & Siam, 2014; Fereidouni et al., 2014). FMOLS estimates a single cointegrating relationship which is having a combination of $I(1)$ variables (Bashier & Siam, 2014). This model concentrates on the transformation of both data and parameters (Park, 1992). Amarawickrama and Hunt (2007) pointed out that FMOLS method makes appropriate correction to the inference problems in traditional EG cointegration technique, and therefore, estimated t-statistics for the long-run estimates are valid. Following Adom et al. (2015) the FMOLS estimator can be obtained as follows.

$$\hat{\sigma}_{FME} = \left(\sum_{t=1}^T Z_t Z_t' \right)^{-1} \left(\sum_{t=1}^T Z_t Y_t^+ - T \begin{bmatrix} \Lambda_{12}^+ \\ 0 \end{bmatrix} \right) \quad (10)$$

In equation (10) Y_t^+ and λ_{12}^+ terms correct the endogeneity and serial correlation. The FMOLS estimator is asymptotically unbiased and has a fully efficient mixture-normal asymptotic distribution, which allows for standard Wald tests using the asymptotic chi-square statistical inference (Adom et al., 2015).

The CCR Estimates

Park (1992) introduced another method, called CCR. This method also can be used for testing cointegrating vectors in a model with the integrated process of $I(1)$. This model too similar in the sense in FMOLS, however, the difference is that CCR concentrates on only data transformation while FMOLS is focusing on the transformation of both data and parameters (Adom et al., 2015; Park, 1992). Further, CCR is a single equation regression in which, can also apply multivariate regression without modification and losing the efficiency (Park, 1992). Following (Adom et al., 2015) the CCR estimator is obtained as in equation (11).

$$\hat{O}_{CCR} = \left(\sum_{t=1}^T Z_t^* Z_t^{*1} \right)^{-1} \sum_{t=1}^T Z_t^* Y_t^* \quad (11)$$

The DOLS Estimates

The DOLS (Stock & Watson, 1993) adopts a parametric approach in estimation of a long-run relationship in a model in which the variables are integrated in a different order, but still cointegrated (Masih & Masih, 1996). This model deals with simultenary bias and small sample bias by including leads and lags (Kurozumi & Hayakawa, 2009). The estimators of DOLS can be obtained from least-squares estimates, and these estimators are unbiased and asymptotically efficient even in the presence of the endogenous problem. The parameters also adjust the possible autocorrelation and residual non-normality (Herzer et al., 2006; Stock & Watson, 1993).

$$y_t = a + bX_t + \sum_{i=-k}^{i=k} \phi_i \Delta X_{t+i} + \epsilon_t \quad (12)$$

In equation (12) b is the long-run elasticity. The term ϕ 's are the coefficients of leads and lags differences of $I(1)$ regressors. These coefficients are considered as nuisance parameters, and they serve to adjust for possible endogeneity, autocorrelation, and non-normal residuals (Herzer & Nowak-LehmannD, 2006; Herzer et al., 2006).

Empirical Results

Unit Root Test

ARDL model is appropriate when the data are purely $I(0)$ or purely $I(1)$ or a mixture of both but not $I(2)$. It should be prevented from entering $I(2)$ variables in the analysis as the ARDL model provides bounds critical values for only $I(0)$ and $I(1)$ series. Therefore, this study performs ADF and PP test to find the order of integration of targeted variables. These two tests are widely

used in econometric literature. Results of both unit root tests are incorporated in Table 1 below. Both the unit root tests are confirming all the variables are $I(1)$.

Johansen Cointegration Test and EG Cointegration Test

Since all the variables are $I(1)$, it does not violate the requirements of applying ARDL model. However, before proceeding for ARDL bound test, traditional cointegration tests, i.e., JJ, and EG residual-based cointegration tests are applied. The lag length is important while performing JJ test. Two lags are included in the JJ test in which, the VAR system does not suffer from autocorrelation and heteroscedasticity problems. To perform the EG cointegration test, residuals taken from OLS method, tests for stationarity by applying ADF test and compares the test statistic with 5% level critical values. If the residuals are stationary, it means the presence of cointegration. The results of JJ and EG tests are integrated into the Table 2 below.

Table 1 ADF and PP unit root test results

Variable	ADF test				Order of integration
	Levels		1 st difference		
	C	C & T	C	C & T	
LPCGDP	3.298599	-0.690392	-3.454097**	-4.747647*	I(1)
LPCGCF	1.284618	-1.786897	-4.461050*	-5.105089*	I(1)
LLF	-0.946577	-2.802160	-6.179892*	-6.145811*	I(1)
LSEXP	-1.152165	-2.470174	-5.549116*	-5.463591*	I(1)
PP test					
LPCGDP	3.298599	-0.690392	-3.508520**	-4.747647*	I(1)
LPCGCF	2.342862	-1.987987	-4.409555*	-7.314530*	I(1)
LLF	-1.619721	-2.820810	-7.896690*	-13.49406*	I(1)
LSEXP	-0.835987	-2.502128	-6.660039*	-6.938997*	I(1)

Note: C=constant, C&T= constant and trend. ADF test was performed using Schwarz information criterion and the automatic lag selection set as 7 lags. PP test was performed with Bartlett Kernel and Newey-West Bandwidth. *, ** and *** indicate significant 1%, 5% and 10% level.

Table 2: Johansen and EG cointegration test results

JJ test				
Hypothesis		Trace statistic	Critical values 5% level	P-values
H ₀	H _A			
CV = 0	CV ≥ 1	55.27325*	47.85613	0.0086
CV ≤ 1	CV ≥ 2	22.30544	29.79707	0.2818
CV ≤ 2	CV ≥ 3	11.24682	15.49471	0.1968
CV ≤ 3	CV ≥ 4	2.789994	3.841466	0.0949
Max-Eigen Values				
CV = 0	CV ≥ 1	32.96781*	27.58343	0.0092
CV ≤ 1	CV ≥ 2	11.05862	21.13162	0.6415
CV ≤ 2	CV ≥ 3	8.456823	14.26460	0.3342
CV ≤ 3	CV ≥ 4	2.789994	3.841466	0.0949

EG cointegration test			
Residual has a unit root	ADF test		
	-5.328081*	-4.09600	

Note: Critical values for EG test was taken from table 3 of (MacKinnon, 2010) for N=4. * indicates that rejection of the H_0 at 1% level.

The first and second panels of Table 2 integrate the Trace statistics and Max-Eigen values and corresponding critical values (5% level) with probability values of JJ test. Both the Trace statistic and the Max-Eigen values reject the H_0 : CV=0 at 1% level. However, none of the tests rejects the second null hypothesis of H_0 : CV \leq 1. Similarly, EG cointegration test also rejects the H_0 at 1% level. Therefore, PCGDP, GCF, LF and SEXP are cointegrated. It implies any deviation in existing equilibrium relationship between the variables are temporary and move together in long-run. The normalized long-run coefficients of three explanatory variables from JJ test are reported in Table 3 below. According to the results, all the coefficients are significant at least at 5% level. These coefficients are not surprising and match with the expected sign of economic theory.

Table 3: Normalized long-run coefficients from Johansen cointegration test

Variable	Coefficient	S.E.	T ratio
LPCGCF	0.384603	0.03496	11.00123*
LLF	1.415461	0.17738	7.979822*
LSEXP	0.026121	0.01282	2.037519**

Note: * and ** indicate significant at 1% and 5% level respectively.

ARDL Bound Test for Cointegration

Next, ARDL bound test for cointegration by Pesaran et al. (2001) is performed. Because the sample consists of 30 observation, the F-statistic of Narayan (2005) critical values also is performed which is suitable for the bound testing approach in a small sample. The final ARDL (1, 0, 0, 0) model is selected, and the model selection method is based on Akaike information criterion (AIC). The results are integrated into Table 4 below (ARDL includes automatic lag selection, lags 4 for dependent variable and lags 3 in independent variable). The F-statistic (29.43473) > upper bound critical value of both Pesaran et al. (2001) and Narayan (2005) at 1% level rejecting the H_0 . The error correction term (ECM_{t-1}) is as desired to prove the presence of cointegration. The sign of ECM_{t-1} should be negative and significant. As shown in Table 5 below, in the analysis, the ECM_{t-1} is -0.198519 ($p=0.017400$). Therefore, it is confirmed that the variables, PCGDP, GCF, LF, and SEXP are cointegrated, which means any change in the current equilibrium level of the economy is a temporary phenomenon and will bring to the long-run path in future. According to the magnitude of ECM_{t-1} , any deviation of the equilibrium will be corrected at the speed of 19.85% annually, or the economy will take approximately five years for full adjustment. To explain further, it is the speed of convergence towards a new long-run equilibrium after a shock due to SEXP.

Table 4: ARDL bound test results

Bound test values		Bounds critical values (at 5% level)			
Test statistics	Value	Pesaran et al., (2001)		Narayan (2005)	
		I(0)	I(1)	I(0)	I(1)
F-statistics	29.4343*	2.79	3.67	3.272	4.306

Note: Critical values for Narayana (2005) is from case II, restricted constant and no trend. These critical values are the correspondent values for k=3, where k is the number of regressors. * indicate the rejection of H_0 at 1% level.

Table 5: Long-run coefficients and error correction term (ECM)

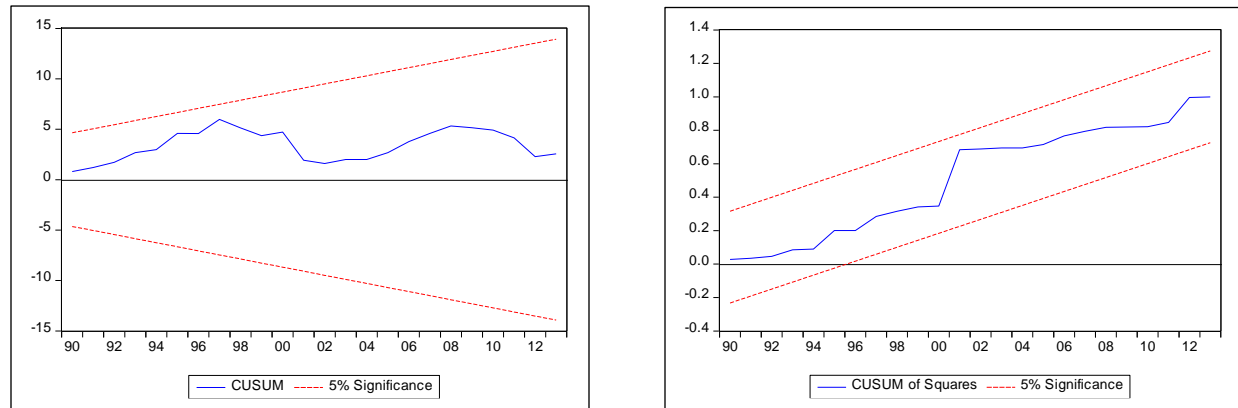
Variable	ARDL	DOLS	FMOLS	CCR
LPCGCF	0.523115* (0.083557)	0.540531* (0.086509)	0.410042* (0.026257)	0.413471* (0.027304)
LLF	0.797357*** (0.451096)	0.506851 (0.421561)	1.347404* (0.145796)	1.326288* (0.152813)
LSEXP	0.101286** (0.038487)	0.095650** (0.029982)	0.040643* (0.010132)	0.043167* (0.011468)
C	3.336834 (4.420351)	5.940822 (4.243404)	-2.225210 (1.414253)	-2.025402 (1.481930)
ECM(-1)	-0.198519 (0.017400)*	-	-	-

Diagnostic test: For ARDL, $R^2=0.998633$, $\text{Adj.}R^2=0.998405$, F-statistic=4382.344(p=0.0000), DW=1.834587, Jarque-Bera statistic=2.243467(p=0.325715), Breush-Godfrey serial correlation LM(2)test=0.181541(p=0.9132), Breush-Pagan-Godfrey heteroscedasticity test=5.186891(p=0.2687), ARCH(1)=0.596877(p=0.4585), Ramsey RESET test(1)=0.3006366(p=0.7664). For DOLS, lags and lead was fixed as 2 lags and 2 leads, $R^2=0.999399$, $\text{Adj.}R^2=0.997597$, S.E=0.014964, long-run variance=0.000160. For FMOLS, Kernel option was set as Bartlett with Newey-West Fixed. $R^2=0.991242$, $\text{Adj.}R^2=0.990191$, S.E=0.035034, Long-run variance=0.000731. For CCR, $R^2=0.991104$, $\text{Adj.}R^2=0.990036$, S.E=0.035308, long-run variance=0.000731. Figures in parenthesis are standard errors. *, **and *** indicate significant at 1%, 5% and 10% level respectively.

The estimated coefficients in ARDL model adequate, only if the model is statistically viable. The bottom panel of Table 5 reports the results of diagnostic tests. The values of R^2 and adjusted R^2 show that over 99% of the variation of PCGDP is explained by the determinants included in the regression. The F-statistic of the model is highly significant indicating that the overall performance of the model is sound. The Jarque-Bera test also of the model accepts the null of "residuals are normally distributed." The LM(2) test shows estimated residuals are not serially correlated and independent each other. Breush-Pagan-Godfrey heteroscedasticity test also indicates that the estimated model is homoscedastic, which is desirable for a good model. Ramsey RESET test result shows there is no chance for errors in general specifications. Further,

CUSUM test and CUSUM of squares tests (figure 1) show that estimated parameters are stable over the period.

Figure 1: CUSUM test and CUSUM of squares test



Long-run Elasticities from DOLS, FMOLS, and CCR

Before drawing a conclusion about long-run coefficients from JJ test and ARDL bound test, the analysis is extended to account for the robustness of long-run parameters by re-estimating the coefficients through FMOLS, CCR, and DOLS. The results are integrated into Table 5 above. The long-run elasticities from these three models also provide very similar results to the JJ test, and ARDL results in signs and magnitudes. The diagnostic test for, FMOLS, CCR, and DOLS are provided in the bottom panel of Table 5. For all three models, R^2 and adjusted R^2 show the regressors in the model explain about 99% of the changes in PCGDP. Standard errors are less than 5% and long-run variances are closed to zero. This goodness of fit indicators of the models show that estimated long-run elasticities are efficient and adequate. To this end, it is obvious that the main variable of interest; SEXP positively and significantly influences on TFP growth in Sri Lanka. This evidence confirms in all five models; SEXP promotes PCGDP at least at 5% level.

Discussion

Per Capita Gross Capital Formation and Per Capita GDP

Many authors have proved that there is a positive relationship between capital and output. Convincing this traditional wisdom, all models in this study also yield a positive and significant association between GCF and PCGDP in Sri Lanka. The long-run coefficients of GCF are 0.384603 in JJ estimates, 0.523115 in ARDL, 0.540531 in DOLS, 0.410042 in FMOLS and 0.473471 in CCR. All coefficients are positive as desired and significant at 1% level. Increasing in GCF implies the increase in capital equipment required in the production process. Capital is an important source to replace the depreciation in the current capital equipment, which helps to prevent the falling of current level of production. Capital also needs to establish new production plants, and expand the existing production plants, which increase the production level and generate new employment opportunities. Furthermore, capital formation helps to acquire advanced technologies and new production techniques. Therefore, GCF and output are positively associated. The results are consistent with Anwer and Sampath (1999) and Bashir, Iqbal, and Nasim (2015) among others.

Labor Force and Per Capita GDP

The results of this study show that LF positively and significantly promotes productivity in Sri Lanka. The estimated long-run coefficients of LF are 1.415461 in JJ estimates, 0.797357 in ARDL, 1.347404 in FMOLS and 1.326288 in CCR. The coefficient in ARDL model significant at 10% level, while others are significant at 1% level. These results reveal that LF positively correlates with productivity in Sri Lanka. Similar result found by Bashir et al. (2015) for Pakistan and the estimated coefficient was 1.159. LF is the most important factors of production in Sri Lanka as a developing country. Availability of well-educated and trained labor force may lead to increase the output in many folds as evidenced by JJ estimates, FMOLS and CCR test in this study. The finding is supported by the fact that Sri Lanka is one the first country achieved a higher level of literacy rate in the Asian region.

Services Exports and Per Capita GDP

SEXP have a positive and significant effect on productivity growth at least at 5% level in Sri Lanka. The estimated long-run coefficients from JJ, ARDL, DOLS, FMOLS, and CCR are 0.026121, 0.101286, 0.095650, 0.040643, and 0.043167 respectively. Thus, it is proved that there is a positive association of SEXP with PCGDP in Sri Lanka. The results are consistent with Dash and Parida (2012), Debnath, Laskar, et al. (2014) and Debnath, Roy, et al. (2014) who investigated the effect of SEXP on productivity in India. Their estimated coefficients were 0.57, 0.14 and 0.29 respectively. SEXP creates competition, economies of scale and allocation of technical progress in the production. SEXP also is attributed as a foreign exchange earning source, facilitating for imports of capital goods and other input, which are required in the production. This finding has important insides. Given a chunk of studies which examined the productivity effect of goods exports, the finding of this study has merits and important policy implications in addition to goods exports in Sri Lanka. The service sector is the most prominent sector in Sri Lanka's economy occupying more than 50% of GDP. Therefore, increasing the competition, efficiency, and productivity in services industry via exports may generate more benefits to the overall economy. Adding the international market to the domestic market provides more space for growth, thereby, improves the absorption capacity of excess and underutilized resources, primarily from the agricultural sector.

Conclusions

This study examines the importance of SEXP on the growth of TFP in Sri Lanka analyzing time series data from 1984-2013. The service sector has become the largest sector in Sri Lanka's economy accounting for more than half of the GDP. With adoption to the trend in global trade, Sri Lanka shows an increasing trend in SEXP standing at 7% of the GDP in 2013. Increasing in SEXP can contribute to the Sri Lanka's economy as follows. First, it earns foreign exchange, which is a need for capital and other intermediate goods import for the production process. Second, increasing the exports in this particular sector implies increased efficiency and productivity. Therefore, increasing the competition, efficiency, and productivity in services sector as the largest sector of the economy, via exports may generate more benefits to the overall economy. Adding the international market to the domestic market provides more space for growth, thereby, improves the absorption capacity of excess and underutilized resources, especially from the agricultural sector. The main finding is that SEXP have a positive and significant impact on

TFP in Sri Lanka, and it is true for across all the econometric models. The study also finds a positive and significant impact of GCF and LF on TFP growth. Unlike to the available empirical studies on this topic, which employ single econometric procedure, this study adopts with the multi-dimensional econometric approach and applies JJ, ARDL, DOLS, FMOLS and CCR in the analysis. Therefore, this study finds more robust and adequate result, which are not sensitive to the econometric model selection. The finding has merits and important policy implications in Sri Lanka. Significant policy intervention to encourage SEXP will boost the overall economic growth via increasing the TFP while it facilitates for the proper transformation of the economy.

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