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Is the State University System in Sri Lanka a "White Elephant"?

K. Renuka Ganedogage
School of Economics
The University of Queensland
Brisbane, QLD 4072, Australia

Alicia Rambaldi
School of Economics
The University of Queensland
Brisbane, QLD 4072, Australia
a.rambaldi@economics.uq.edu.au

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K. Renuka Ganegodage and Alicia N. Rambaldi

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School of Economics. The University of Queensland, St Lucia, QLD 4072. Australia.

Abstract

Sri Lanka allocates considerable resources to maintaining universities each year; however, there has not been any empirical investigation of the impact of university education on national output. The paper covers the period 1959-2008, a period that includes substantial changes in economic policies, the ethnic war and civil insurgencies. We generalize Lau and Sin (1997 a and b) common methodological framework for both neoclassical and endogenous growth models and use an ARDL framework to estimate the econometric model. We found that there have been positive returns to investments in human capital (measured by a quality adjusted stock of university graduates); however, the returns are significantly lower than those found for other developing economies. The returns to physical capital are higher. However, we find that higher returns from investment in physical capital cannot produce any sizable positive externalities under current conditions as it would be the case in a more developed economy. Civil unrest has had the expected negative effect on aggregate output.

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Keywords: University Education, Physical capital, Human capital, Externality effects.

1 Introduction

Sri Lanka has been widely cited as an example of a developing country with an outstanding achievement in educational targets. Human capital accumulation through education has been one of the top priorities of its national policy as the authorities see education as an investment with returns in the economic and social well being of the nation [Isenman, 1980, WorldBank, 2005, Hess and Ross, 1997]. The level of Sri Lankan economic performance however, is far behind its the level of educational achievements. More importantly, the effect of 'educational development' on Sri

Lanka's economic growth seems marginal as many other East Asian nations with similar level of educational achievements have shown faster economic growth compared to that of Sri Lanka. Sri Lanka is a country with free education from kindergarten to university [Visaria, 1981, WorldBank, 2005][1]. Though free education at the primary educational level is recommended for developing countries, the free availability of university education is provocative as some studies have shown a lower social gain from higher education compared to that of primary education [Todaro and Smith, 2009, WorldBank, 2005]. Moreover, the Sri Lankan education sector as a whole receives a budgetary allocation of around 3 % of national income, while on average countries in the low and lower middle income groups spend respectively, around 3.2 and 4.1%. Sri Lanka is classified as a middle level income group country (`http://go.worldbank.org/K2CKM78CC0`), and therefore it allocates less than the average level of its income group. This is because it lacks resources to invest in education due to slow economic growth [WorldBank, 2005]. However, by international standards, the recurrent expenditure per student as a percentage of income per capita at the tertiary level is high. Sri Lanka spends an amount equivalent to the average income per capita on a student at the tertiary level while the relative figure for South Asia stands at around 84% of the average national income per capita. Thailand, Singapore and India spend around 25, 34 and 93% respectively relative to their income per capita on a student at a tertiary institution. Thus, government universities in Sri Lanka allocates a high share of the per student budget at the expense of primary and secondary schooling. Thus, the main question is whether the availability of free education for university students is an appropriate policy for the Sri Lankan economy in terms of its impact on the economy.

There are several studies that have examined the relationship between educational achievement and economic growth, many of these are cross country analyzes. There is no comprehensive study of university education and its impact on the economic growth of Sri Lanka [Abbas, 2001]. Using a simple regression approach, Abbas [2001] examined the effects of educational performance at primary, secondary and higher levels on the economic growth of Sri Lanka during the period 1970-1994 and concluded that education at the secondary level has the highest returns while higher education provides significant, but marginal returns. This study does not describe whether the definition of higher education considered universities and other tertiary institutions. Other research into the Sri Lankan educational sector has not aimed at studying the relationship between educational achievement and economic growth [Little and Sabates, 2008, Himaz, 2010].

In general there is no consensus on the impact of educational performance on economic growth.

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[1]Though there exist a few private schools and universities, public education is dominant in Sri Lanka. Figures for 2006 show over 97 percent of students study in government schools and over 99 percent of schools are state owned (MinistryofEducation, 2007). University education in Sri Lanka is largely state dominated as well (CentralBank, various years). However, there are increasing numbers of private institutions affiliated to foreign universities that offer degree programs. These are for those who are unable to enter the state universities or cannot afford studies in foreign universities. The standards and the quality of these institutions are not guided by a regulatory body in Sri Lanka and some reports indicate that these are attached to unreliable foreign institutions. However, statistics on enrollment at these private providers is yet to be published.

For instance, using cross country comparisons, while Gemmell [1996] and Barro [1991] found a positive relationship between education and economic growth, Devarajan et al. [1996] show a negative relationship between education expenditure and economic growth. Thus, this paper aims at evaluating the effects of education at university level on the economic growth of Sri Lanka. The investigation is conducted for the period 1959-2008.

During the study period Sri Lanka experienced significant changes in economic policies pursued by different governments and political parties which directly affect the openness of the economy. After 1956, due to a political power shift from the right to the left, the government introduced import substituting economic policies as a remedy for unemployment and balance of payment difficulties, the latter due to the dependence on a colonial plantation economy dominated by three major crops: tea, rubber and coconut. During 1972-1976, Sri Lanka was identified as one of the most regulated inward-oriented economies outside the communist block [Athukorala and Rajapatirana, 2000] due to a policy of tightening to overcome the effects of the oil shock. In 1977, this trend ended with the introduction of a liberalization program. During this period, the effect of the ethnic war cannot be underestimated as the impact of the separatist movement in the Northern and Eastern part of the country during 1983-2009 has been the major crisis faced by the nation. Beyond the direct effects such as outlays and civilian and military casualties and deaths, this war has affected foreign direct investment flows, which are essential to improve the country's capital stock (Athukorala and Rajapatirana, 2000). The ethnic war was conducted in four phases: Eelam War I-IV. In addition, civil insurgences in 1971 and 1987-1990 launched by a group of radical youth in the southern part of the country and an electricity crisis combined with the effect of the civil war resulted in a significant economic growth slowdown in Sri Lanka in 2001. These events are considered in the estimation.

The rest of the paper is organized as follows. The next section presents the theoretical framework. This is followed by a description of econometric modeling in Section 3. Section 4 presents the empirical results. The final section provides a summary and conclusions of the study.

2 The Theoretical Framework

2.1 The Original Lau and Sin Framework

The model used in this study is a generalization of the Lau and Sin [1997a] -LS(a) and Lau and Sin [1997b]'s- LS(b) common framework for both neoclassical and Romer's growth models. The difference between the neo-classical and Romer's [Romer, 1986] models is in the specification of technology. The neo-classical production function exhibits constant returns to scale with respect to inputs and the explanation of a sustained growth relies on external technological progress and therefore growth is exogenous. Technology can be captured by a time trend (see LS (a)). In Romer's framework growth is derived as an externality effect to other firms when a firm invests in physical

capital(knowledge as capital arises due to investment in physical capital). Thus, perpetual growth is based purely on a time invariant economic environment and therefore, growth is endogenous. A significant time trend is an indication of steady-state growth and therefore consistent with the exogenous growth model. LS (a) presented the neoclassical and Romer's production functions as a special form of a Cobb Douglas production function for firms or households:

$$Y_t = AK_t^\alpha \left[(1+\gamma)^t L_t\right]^{1-\alpha} \kappa_t^\lambda \varepsilon_t^p \tag{1}$$

where,

$\gamma \geq 0, 0 < \alpha < 1$, $A > 0$;

Y_t, K_t, L_t and A are output, capital, labor and the level of technology in period t, respectively;

κ_t can be interpreted as the average physical capital stock or the public knowledge which is an input to the individual or the firm's production and it is an externality from the point of view of the optimizing household.

α is private returns to physical capital;

λ is the externality of physical capital;

ε_t^p is a random a productivity shock in period t.

To consider both the neo-classical and endogenous models within one form for the empirical study, LS(a) and LS(b) decompose the exogenous productivity impulse process (total factor productivity) into two components, a) the deterministic component $\left[(1+\gamma)^t\right]^{1-\alpha}$ and b) the stochastic component ε_t^p. For the deterministic component, the technological process is assumed to be labor augmenting and an exogenous factor to the production process. It grows at a constant average rate denoted by $\gamma(\gamma \geq 0)$. Any possible 'trend' growth in the productivity impulse process is captured by this deterministic component. Thus, ε_t^p, the stochastic component, is trendless. The productivity impulses in log values are modeled as an autoregressive stochastic process without a drift. i.e:

$$\ln \varepsilon_t^p = \zeta_i \ln \varepsilon_{t-1}^p + v_t^p \tag{2}$$

where, $0 \leq \zeta_p \leq 1$, v_t^p is a white noise process. Thus the log form of ε_t^p is as an autoregressive stochastic process, and can be $I(0)$ or $I(1)$ without drift because the drift is already captured by the trend component, t.

For the endogenous growth model, technology is not exogenous, thus, leading to the restriction, $\gamma = 0$. Random productivity shocks should be $I(0)$. Then all log variables considered are difference stationary (LS (a)). In the case of exogenous growth, $\gamma > 0$ and $\lambda = 0$, the external impulses can be $I(0)$ or $I(1)$. The variables are difference stationary, if at least one external impulse is $I(1)$. Otherwise, variables are trend stationary.

LS simplified several features of the model to ensure the availability of closed form solutions. These include the assumptions of a logarithmic utility function, and a Cobb Douglas production

function with 100% depreciation per period. Since these simplifications (assumptions) maintain the fundamental difference of both growth models, constant versus decreasing returns with respect to inputs, the long run behavior is not changed. LS assume a closed economy with N (large) number of identical agents, the government, and inelastically supplied labor input. Households and firms take policies as given to make their decisions. An agent (household/firm) of the economy chooses a consumption path to maximize the expected lifetime utility (to choose $\{c_t, k_{t+1}\}_{t=0}^{\infty}$ to maximize utility), which can be expressed in a log form, as:

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t \ln c_{jt} \right] \tag{3}$$

where,

E_t and, c_{jt} respectively denote the expected values conditional on the information set at time t and the consumption level of agent j $(j = 1, \dots N)$ at time t; $\beta \epsilon (0, 1)$ is the discount factor. LS (b) assumed that government expenditure is financed by a proportional income tax and the budget is balanced every period[2]. The resource constraint of the closed economy is given as:

$$Y_t = C_t + I_t + G_t \tag{4}$$

where,

C_t and I_t are respectively, the aggregate level of consumption and investment expenditure at time t.

$G_t = \tau Y_t$ and τ is the tax rate.

At any time, each individual has to make decisions to allocate output on consumption and investment according to the tax rate, major policy strategies and the level of aggregate inputs given.

The LS framework is used to derive a generic growth model for the Sri Lankan economy which considers both human capital and economic openness. Specifically, LS (b) generalize LS (a) to analyze public infrastructure and in this study we generalize the framework to include human capital and an open economy.

2.2   Modified Lau and Sin model

In this paper, we extend LS's framework in two directions: a) relax the assumption of a closed economy; b) divide capital into physical and human capital stocks. To relax the closed economy assumption, we modify the resource constraint given in equation (4) and assume imports and exports are balanced in each period.

Therefore, the resource constraint of the economy can be re-written as:

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[2]These features simplify the derivation of the integration and cointegration properties of the variables (see LS(b) p.128.

$$Y_t = C_t + I_t + G_t + X_t - M_t \tag{5}$$

where,

X_t and M_t are respectively imports and exports at time t and $X_t - M_t = 0$;

The separation of capital stock into two components and the open economy assumption add two variables to the LS model, human capital and a measure of openness. Following LS (b), these are considered as external effects to the model, since the standard growth model has labor and physical capital as inputs. At time t, an agent's production function in Cobb Douglas form can be expressed as[3]:

$$y_{jt} = A k_{jt}^\alpha \left[(1+\gamma)^t l_{jt} \right]^{1-\alpha} \tilde{K}_t^\lambda \tilde{H}_t^\varphi \tilde{O}_t^\eta \varepsilon_t^p \tag{6}$$

$$t = 1 \ldots T, \ A > 0, \ 0 \le \alpha, \ \lambda, \ \varphi, \ \eta < 1$$

where,

y_{jt}, k_{jt} and l_{jt} are the output, the capital, the labor inputs of agent j at time t respectively and $\tilde{K}$, $\tilde{H}$ and $\tilde{O}_t$ are respectively the congestion adjusted available physical capital, human capital (at aggregate level), and openness at time t.

α is private returns to physical capital, and

λ, φ and η are respectively the externality effects due to physical capital, human capital, and the openness of the economy.

The function in equation (6) exhibits constant returns to scale with respect to capital and labor inputs of a representative agent. A competitive equilibrium exists with the payments to all private inputs according to their marginal products just exhausting the output.

There is congestion among the allocation of resources for physical and human capital as well as for external trading activities due to openness. That is, it is assumed that some government resources are allocated to sustaining an open economy and therefore suffer some congestion. In the literature, there are two definitions for congestion, namely, relative congestion and aggregate congestion. Relative congestion refers to the level of services derived by an individual from the provision of a public good in terms of the usage of his individual capital stock relative to the aggregate stock. Aggregate congestion is how the aggregate usage of the service along influences the services received by the individual (Eicher and Turnovsky, 2000).

The congestion effect is modeled as follows:

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[3]The variables considered to assess the impacts of war and civil unrest will be added to the econometric formulation as dummy shifts

$$\tilde{K}_t = \frac{K_t}{K_t^\phi \left[(1+\gamma)^t L_t\right]^{1-\phi}}, \tilde{H}_t = \frac{H_t}{K_t^\phi \left[(1+\gamma)^t L_t\right]^{1-\phi}}, \tilde{O}_t = \frac{O_t}{K_t^\phi \left[(1+\gamma)^t L_t\right]^{1-\phi}} \qquad (7)$$

where,

$0 \leq \phi \leq 1$. K_t and H_t are aggregate levels of physical capital and human capital stocks respectively.

O_t is the measure of openness,

The specification of the congestion effect on all variables is assumed the same. If ϕ equals zero, the extent of congestion is related to the size of the population. If $\phi = \alpha$, the congestion is due to the production process.

As in LS(b) productivity impulses for variables are derived as autoregressive stochastic processes and the production function per efficiency unit can be expressed as (after substituting 7)[4]:

$$\hat{y}_{jt} = A k_{jt}^\alpha \tilde{K}_t^\lambda \tilde{H}_t^\varphi \tilde{O}_t^\eta \varepsilon_t^p = A \hat{k}_{jt}^\alpha \hat{\kappa}_t^{\lambda-(\lambda+\varphi+\eta)\phi} \hat{h}_t^\varphi \hat{o}_t^\eta \varepsilon_t^p \qquad (8)$$

where,

$\hat{y}_t$, $\hat{\kappa}_t$, $\hat{h}_t$, and $\hat{o}_t$ are, respectively, the average level of output, physical capital, human capital and openness per efficiency unit at t.

$\hat{k}_{jt}$ denotes the individual's capital.

At equilibrium $\hat{\kappa}_t = \hat{k}_{jt}$ (this follows LS(b) p. 128).

Thus:

$$\hat{y}_t = A \hat{k}_t^{(\alpha+\lambda-(\lambda+\varphi+\eta)\phi)} \hat{h}_t^\varphi \hat{o}_t^\eta \varepsilon_t^p \qquad (9)$$

The above equation provides solutions to Romer's model as $\gamma = 0$. However to consider the neoclassical model, γ should should appear to represent the rate of (exogenous) technical progress. Therefore, we express (1) in per capita terms:

$$y_t = A k_{jt}^\alpha (1+\gamma)^{t(1-\alpha)} \tilde{K}_t^\lambda \tilde{H}_t^\varphi \tilde{O}_t^\eta \varepsilon_t^p = A k_t^{(\alpha+\lambda-(\lambda+\varphi+\eta)\phi)} (1+\gamma)^{t(1-\alpha-(1-\phi)(\lambda+\varphi+\eta))} h_t^\varphi o_t^\eta \varepsilon_t^p \qquad (10)$$

y_t, k_t h_t and o_t are, respectively, the level of output, physical capital, human capital and openness per capita at t.

The equilibrium relationships for each variable are obtained by expressing each variable in terms of its own lags and the external impulses. The resulting motion for the log of output per capita, $\ln y_t$, is:

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[4]To solve for an equilibrium condition, LS(b) defined the model in per efficiency units by dividing $(1+\gamma)^t$ (to handle the problem of $\gamma > 0$) using the artificial planning problem (Glomm and Ravikumar [1994]; Lau and Sin [1997b]

$$[1 - (\alpha + (\lambda + \varphi + \eta)(1 - \phi))B] (\ln y_t - \gamma_t) = a_y + \ln \varepsilon_t^p + (\alpha + \lambda - (\lambda + \varphi + \eta)\phi) \ln \varepsilon_t^K + \varphi \ln \varepsilon_t^H + \eta \ln \varepsilon_t^O \tag{11}$$

where,

$a_y = [1 - (\alpha + (\lambda + \varphi + \eta)(1 - \phi)] \ln A + (\alpha + \lambda - (\lambda + \varphi + \eta)\phi a_1 + \varphi a_2 + \eta a_3,$

$a_1 = \ln[\beta\alpha(1 - \tau)A] - \gamma$

$a_2 = \ln(a\tau A) - \gamma$

$a_3 = \ln[(a - 1)\tau A] - \gamma$

a is the portion of the budget allocated to human capital.

B is the backshift operator.

In order to obtain meaningful growth paths in both endogenous and exogenous growth models, each variable exhibits perpetual but non-explosive growth, and the order of integration of the log form of the variable is at most one. The endogenous growth model is consistent with the restriction $\gamma = 0$ as technology is not exogenous. Additionally, to ensure perpetual and non-explosive growth $\alpha + (\lambda + \varphi + \eta)(1 - \phi)$ should equal to 1 and all external impulse processes, random productivity shocks due to physical and human capital and the measure of openness should be $I(0)$. And thus, level variables are difference stationary. In the case of exogenous growth, to achieve a meaningful growth path we require $\gamma > 0$ and $\alpha + (\lambda + \varphi + \eta)(1 - \phi) < 1$, the external impulses can be $I(0)$ or $I(1)$. The variables are difference stationary, if at least one external impulse is $I(1)$. Otherwise, variables are trend stationary.

3 Econometric Modeling

The growth model in (10) is tested and estimated using the bound testing (ARDL) approach proposed by Pesaran et al. [2001]. The approach is designed to study relationships in levels and it does not require pre-testing for unit roots individual regressors and therefore is considered more efficient in estimating cointegration relationships when samples sizes are small as is the case in this study [Baharumshah et al., 2009, Fosu and Magnus, 2006]. The model in (10) can be expressed in log form as follows[5]:

$$\ln y_t = \beta_1 + \beta_2 \ln k_t + \beta_3 \ln h_t + \beta_4 \ln o_t + \beta_5 t + \ln \varepsilon_t^p \tag{12}$$

where,

$$\beta_2 = \alpha + \lambda - [(\lambda + \varphi + \eta)\phi], \beta_3 = \varphi, \beta_4 = \eta, \beta_5 = \gamma(1 - \alpha - [(1 - \phi)(\lambda + \varphi + \eta)] \tag{13}$$

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[5]assuming γ is small $\ln(1 + \gamma)$ is approximated by γ (see LS b p.129). This cointegrating relationship can be derived from the equilibrium relationship of each variable as well (see LS(b) Appendix).

$\ln \varepsilon_t^p$ is assumed $I(0)$

β_i coefficients are elements of the cointegration vector.

The theoretical model given in equation (10) and the econometric model in equation (12) will enable us to evaluate several theoretical aspects of the economic growth in Sri Lanka. These include determining whether the Sri Lanka data are consistent with an endogenous or exogenous growth model, and which is the impact of human capital, physical capital and the openness of the economy on the economic growth of Sri Lanka. To aid the discussion of the results in the next section, Table 1 provides the link between the theoretical framework and the econometric approach by showing the mapping from the economic framework to the empirical testing and estimation steps carried out to obtain the results. For example, if the data are consistent with cointegration and $\gamma = 0$, then we will conclude that there is evidence to support endogenous growth for Sri Lanka during the sample period.

[Table 1 here]

3.1 Variables and Data

The main variables of the model are physical capital, human capital, labor and the measure of openness. There are no published capital stock data series for Sri Lanka for the 1959- 2008 period; therefore, the capital stock data series was estimated using the perpetual inventory formula used in Binder and Pesaran [1998] with a 4% depreciation rate. Since a continuous set of data on the labor force is not available for the whole period, working age population (that is the population age between 20 and 64) is taken as a proxy for the labor force.

To analyze the effect of human capital, we consider education as a stock to represent the stock of human capital available to the nation. To construct this human capital stock, we first construct a level variable in the form of an index. The level variable is a "quality adjusted" measure of graduate output. We use the ratio of lecturers:students at state universities to adjust for quality of the annual number of graduates from state universities. The index is defined as the predictions from a multiple regression model. The model is:

$$GO_t = \delta_1 LS_{t-1} + \delta_2 GO_{t-1} + \delta_3 t + \epsilon_t \tag{14}$$

where, GO is the number of graduates from all undergraduate programs at Sri Lankan state universities at time t; LS is the ratio of lecturers:students at time t; and, t is a time trend. The predicted values from (14), $\widehat{GO}_t$ are used as the index.

The human capital stock, H_t, is constructed using the levels, $\widehat{GO}_t$, and the perpetual inventory formula with the same depreciation rate as that used for physical capital (Mankiw et al., 1992).

The ratio of the combined value of exports and imports to Gross Domestic Product is used as the measure of openness, O_t. We incorporate dummy variables for insurgencies in 1971 and

1987-1990 (DIN), the economic slow down of 2001 (D01), and the ethnic war (DWAR) covering the periods 1985-1993 (Eelam War I & II), 1995-2001 (Eelam war III) and 2006- 2008 (Eelam War IV). In addition, a dummy for 1972-1977 (DO) is incorporated to represent the period with most inward looking economic policies. Data are gathered from various issues of the Annual Reports of the Central Bank of Sri Lanka and the World Development Indicators (WDI) for the period 1959-2008. The next section presents the empirical results.

4   Empirical Results

We use the ARDL approach of Pesaran and Shin, 1999 and Pesaran et al., 2001 for testing and estimation. The variables are *output* ($\ln y$), *physical capital* ($\ln k$), human capital: *graduate capital* ($\ln h$) and *openness* ($\ln o$). Following the steps outlined in Table 1, we first conduct testing to select the order of the VAR, p. We test up to a maximum lag length of 6 due to the fact that the data are annual and the sample size is limited. Results are presented in Table 2. The SC statistics suggest a VAR of order 1 while AIC, HQ, LR and FPE statistics select order 6. Following the method described by Pesaran et al. [2001], we select a middle value, order 3^6. Thus, we estimate ARDL of orders up to 3. We find that the simplest model is an ARDL(0,1,2,3) which is then used for the testing and estimation.

[Table 2 here]

The second step is to find evidence for the exogenous/endogenous growth model. This includes testing for cointegration and for a non-zero deterministic trend. The computed F value for testing the existence of the long run equation is 4.63, which is greater than the upper bound of the critical value provided by Pesaran et al. [2001](Table CI(iv) (p. 301): critical value bounds at 5 percent: 3.38 for *I(0)*, 4.23 for *I(1)*). This suggests the existence of a cointegration relationship. The coefficient of the time trend inside the cointegrating vector is not significant ($\beta_5 = \gamma$). Therefore, the existence of cointegration is again tested without a time trend. The computed F value is 4.94 (the upper bound of the critical value is (Table CI(iii) (p.300)) at the 5% level 3.23 for *I(0)*and 4.35 for *I(1)*). This suggest the existence of cointegration without a time trend as well. These findings are consistent with an endogenous growth model (LS a,b).

We do not impose constant returns to scale on the coefficients as we test whether growth is explosive. This is tested by the null hypothesis that $\beta_2 + \beta_3 + \beta_4 = 1$. The computed F test value is 0.89. Acceptance of the null of constant returns to scale is interpreted as to indicate that the Sri Lankan economy has reached its equilibrium.

The estimation is a two step procedure (see Pesaran et al. [2001]). The estimated level relationship of the ARDL(0,1,2,3) is (with standard errors in parentheses):

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[6]We also check the order of integration of individual variables using ADF, Phillip Perro, and KPSS. We did not find any evidence of $I(2)$. Results are available upon request.

$$\widehat{\ln \hat{y}_t} = \begin{array}{ccc} 0.98 \ln k_t + & 0.20 \ln h_t & -0.14 \ln o_t \\ (0.01) & (0.03) & (0.05) \end{array} \tag{15}$$

The estimated coefficients are significant at the 5% level and have expected signs except for the variable openness (details shortly).

In the second step of the estimation the adjustment coefficients (coefficient of the error correction term-ECT) and the short run dynamics are obtained (Table 3).

[Table 3 here]

The estimated adjustment coefficient is significant but it is small in magnitude (-0.11) indicating that adjustment back to equilibrium from a shock to output is slow. The estimated coefficients for the dummy variables D01, DIN are significant with expected signs, while the coefficient of DWAR is not significant. We discuss these results in turn.

Some of the structural parameters in equation (9) can be directly recovered from the estimation of the level relationship (12). The estimated coefficient of human capital and openness are elasticity estimates ($\beta_3 = \varphi$ and $\beta_4 = \eta$). The elasticity of physical capital, i.e. private return to physical capital (α) and the externality effect of physical capital (λ), are functions of estimates. Both of these estimates depend (see (13)) on values of estimated coefficients and the parameter of the congestion effect. We discuss shortly how we obtain these estimates.

The estimate of the externality effect of human capital (φ) is positive and implies that a one percent increase in the stock of human capital (graduate capital) would result in approximately 0.20 percent increase in output. This magnitude is relatively low compared to those reported for fast growing developing countries. Tallman and Wang [1994] found around a value of 0.5% for the Taiwanese economy indicating the crucial role of human capital in its fast economic growth. Since the Sri Lankan economy is no longer predominantly agrarian, higher education is expected to play an important role in accelerating its economic growth [Horii et al., 2008, CentralBank, various years]. The availability of higher education is limited as less than three percent of students at university entrance level receive placements at state universities. Thus, returns to university education would be expected to be higher than these results indicate. However, this is not a surprising result as other studies have found a failure of university education to cater for the labor market (WorldBank, 2005). According to the WorldBank [2005] and the Central Bank of Sri Lanka (CentralBank [various years]), there are several factors that contribute to youth unemployment. Slow growth of the economy is identified as the main cause of the problem. Moderate quality of some university programs and graduates with low generic skills leads to a state of mismatching between the skill levels of undergraduates and the job market needs in terms of creativity, flexibility and adaptability, effective communication (the level of English knowledge) and problem solving skills are identified as other factors. In addition, frequent disruptions to university education is also identified as a factor related the low quality. These disruptions are due to student union actions

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driven by short sighted political goals [CentralBank, various years]. According to the Central Bank of Sri Lanka CentralBank [various years] the achievements in university education are far behind international levels. There is also evidence that the quality and performance of the entire education system is constrained by the unsatisfactory state of educational quality in the primary grades [WorldBank, 2005]. In addition, the brain drain, especially after 1975, may have had a major impact on the Sri Lankan economy as well. Since the 1970s many highly skilled people have left the country as skill migrants to western countries Dissanayake [2008].

The estimated coefficient associated with openness has a negative sign with the implication that output was inversely related to openness over the sample period. The coefficient implies that a one percent increase in openness (ratio of exports + imports to GDP) resulted in a 0.14 percent reduction in output. Other empirical investigations have supported the findings of the current study which shows a negative impact of the openness policies. Athukorala and Rajapatirana [2000] and Athukorala and Jayasuriya [2000] investigated the past performance of economic policies with special reference to the liberalization policies introduced in 1977. According to these studies, in the early 1960s, the socialist center left political leadership opted for inward-looking, import-substitution policies as a development strategy to overcome a large balance of payments problem due to the dependence on imports and traditional exports, and to increase the employment opportunities due to a population explosion. Despite the substantial reduction in imports of consumer goods, imports of capital goods and raw material increased heavily (to initiate local industries) with results contrary to expectation. In 1977, Sri Lanka became the first country in South Asia to adopt liberalization policies which included a reduction in subsidies, limitations on budgetary transfers and limitations on inflationary financing of the budget deficit. It is difficult to isolate the impact of liberalization policies on economic growth due to inappropriate macroeconomic policies and other calamities that prevailed from the mid 1980s. The major macroeconomic imbalances resulted from the political interests on the massive public sector investment on irrigation projects, housing schemes and transport. In addition, the ethic war, followed by civil insurgencies at the end of the 1980s severely affected economic growth. These interruptions resulted in severe economic disruption, sharp escalation of the defense expenditure leading to a widening in the fiscal deficits, growing macroeconomic problems and erosion of international competitiveness of the tradable sectors. For instance, by 1988, the civil unrest depleted the country's foreign exchange reserves down to the equivalent of six weeks imports while the service payments on external debt increased to 28 percent of export earnings. The dummy variables, D01 for growth slow down and war, and DIN for civil unrest in 1971 and during 1987-1990 used in our estimation are significant and show respectively 0.13 and 0.02 reduction in output. There were no significant changes in manufacturing sector performance unit mid 1980s. After 1985, foreign direct investment due to liberalization policies resulted in a rapid increase in manufacturing sector exports, especially garment industries, but in later years these were hit by the increasingly competitive neighboring countries. In addition, due to the prevailing ethnic war, Sri Lanka failed to attract high tech industries in which it could

have achieved an edge in international production. Malaysia, Taiwan and other rapidly growing countries (NICs) achieved their performance through these high tech industries. Therefore, the effects of open economic policies were hampered due to several factors, namely, inappropriate macroeconomic policies; the military burden, civil unrest; failure to attract foreign investments in high tech industries and a lack of competitiveness in the international market. Though the estimated coefficient of the dummy for ethnic war (DWAR) is not significant, the effects of the war are reflected in the negative outcomes of the liberalization process.

The estimated coefficient for the human capital variables and openness have to be used to recover the externality effect of physical capital and its private returns. In the literature, there are several interpretations for these two returns. Due to investment in physical capital, there are private returns to firms and social returns to the society. The social returns are due to the knowledge gained through the production process. For instance, if a firm invests on technological innovations, it has private returns to the firm due to its investment, and there are social returns because of the invention. Those innovations are filtered into the society and cannot be prevented from being publicly available. Lucas [1988] viewed these external benefits as the gain in knowledge through job training, learning by doing etc. However, in Sri Lanka, research and technology development is almost negligible compared to the developed nations. Sri Lankan technological improvements are mainly through the flow of foreign direct investment. Due to the foreign technology component in physical capital, when firms earn their private returns there may be external benefits to the society due to the enhancement of labor quality, job training and learning by doing. Additionally, there are social returns due to improvement in the quality of life. The externality effect of physical capital, λ can be recovered as:

$$\lambda = [\beta_2 + ([\beta_3 + \beta_4] \phi) - \alpha] / (1 - \phi) \tag{16}$$

The externality effects include not only the social benefits due to the physical capital investment but also other effects. In this analysis it is a combination of the effects of physical capital, human capital and openness. It is clear from (16) that λ depends on α (private return to physical capital) and on the congestion effect parameter, ϕ. As indicated in Table 1, $\alpha = \beta_2 + \beta_3 + \beta_4$ if $\phi = 1$ in which case λ will be either $+\infty$ or $-\infty$. Thus, there is an identification problem. However, we can calibrate for a feasible range in the parameters space. Before presenting the calibration we note that previous estimates of the income elasticity of physical capital, α, for developed countries has been found to be 0.33 (Mankiw et al. [1992]) although it has been found to be much higher for less developed countries (Tallman and Wang [1994] estimated 0.66 for Taiwan's economy). Since Taiwan's economy is a fast growing economy, the coefficient estimate for physical capital for Sri Lanka should be higher than for Taiwan. Lucas [1990] also found higher returns to capital in developing countries, his argument is that the marginal returns to capital is 50 times higher in India compared to returns in the USA. As a rough indication we note that using the estimates

from (15) and setting $\phi = 1$, the value of α would be 1.04 which is much higher than that reported for other countries.

The calibration exercise is presented in Figure 1, where we show the estimates of λ obtained for combinations of α =0.33, 0.66, 0.75, 0.90, 1.00, 1.04 and ϕ =0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9.

[Figure 1 here]

The figure shows the alternative values of the externality effect of physical capital, λ, obtained by varying the values of α and ϕ given the estimates of $\beta_2, \beta_3, \beta_4$ in equation (15). If the value of α is 0.33, consistent with estimates for developed countries, as the congestion parameter ϕ approaches 1, consistent with the economy in equilibrium, the externality effect of physical capital increases rapidly reaching a value of over 7.06 at $\phi = 0.9$. However, the value of λ is substantially smaller as ϕ increases when α is 0.66 (the value estimated by Tallman and Wang [1994] for the Taiwanese economy). As the return to physical capital, α approaches 1, the externality effect tends to disappear and for sufficiently large values (over 1.04 in our case), it can revert sign and start to have a negative effect. Given the literature seems to agree that the returns to physical capital, α, is higher for less developed countries, then these results would indicate that for the current set of estimates of Sri Lanka's structural parameters, the externality effects of physical capital are very small at best.

5   Summary and Conclusion

The study extends the theoretical framework of Lau and Sin [1997a] and Lau and Sin [1997b] to investigate the impact of higher education on the aggregate output of Sri Lanka during the period 1959-2008. In addition, it evaluates the impact of war and changes in government economic strategies on economic output. The empirical analysis shows that physical capital is a key variable that affects the long run growth path of the economy. The question is whether the effort of resource allocation to human capital development through university education contributes positively to economic growth. We found the return is positive but relatively small. Therefore, the resource allocation to human capital through university education is justifiable; however, the small magnitude of the estimated coefficient indicates a need for an appropriate policy debate on how scarce resources should be used to improve the returns of human capital to the Sri Lankan economy. Although this study has not empirically assessed any of the underlying causes of those low returns, other studies have pointed to a mismatch between undergraduate skills and the needs of the job market that may contribute to this lower outcome. At present, there is a significant number of unemployed graduates in many fields of studies except for a few such as medicine and information technology. Many state university graduates are unemployed as there is no demand

either within or outside the country for the degrees they have completed. The course structure within the state universities, which is the largest sector of the country's university system, seems outdated. Due to these reasons, many intellectuals often argue for the need of private universities in the country. However, efforts to establish private universities have been blocked due to political sensitivities. There are a few established private higher education institutes although they are not labeled 'universities' and there is little evidence that the education provided by these meets adequate standards. Sri Lanka has already experienced insurgencies due to the frustration of educated youth in 1971 and 1987-1990; thus, it seems important for the country to engage on an appropriate policy debate on the best future policies for the university system.

The estimated returns from changes in economic strategy to an open economy have been negative during this period. This is contrary to prior expectations in general; however, consistent with results obtained by other empirical studies for the case of Sri Lanka. It has been argued that the liberalization process introduced from 1977 has not been successful partly due to improper politically driven economic policies, the failure to attract foreign direct investment, war and civil unrest. Our findings indicate that higher returns from investment in physical capital are unlikely to produce any sizable positive externalities under current conditions as it would be the case in a more developed economy. From a policy perspective, this is a very important finding. Given the ethnic conflict has finally come to an end, the introduction of a policy framework that can attract foreign direct investment and thus allow Sri Lanka to benefit from an open economy should be given priority.

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Table 1: A Schematic Diagram of the Inter-relationship Between the Economic Model and The Econometric application

THEORETICAL MODEL	ECONOMETRIC APPROACH
1) GROWTH MODEL	1) SPECIFICATION OF THE ECM
$y_{it} = Ak_t^{(\alpha+\lambda-(\lambda+\varphi+\eta)\phi)}h_t^{\varphi}o_t^{\eta}\varepsilon_t^P$	a) lag length test
	b) test for cointegration $e_t \sim I(0)$
Neoclassical ($\varepsilon_t^P \sim I(0)$ or $I(1)$)	$e_t \sim I(0)$ or $I(1)$
Endogenous	$e_t \sim I(0)$
	c) Test for time trend in the cointegrating relation
Neoclassical	$\gamma > 0$
Endogenous	$\gamma = 0$
2) RECOVERY OF PARAMETERS OF THE GROWTH MODEL	2) ESTIMATION OF COINTEGRATION VECTOR
	$\ln y_t = \beta_2 \ln k_t + \beta_3 \ln h_t + \beta_4 \ln o_t + \beta_5 t$
φ_1 = externality effect of human capital measured as the graduate stock from university education	β_3
η = externality effect of the openness of the economy	β_4
γ = effect of technological change	$\beta_5/(1 - \beta_2 - \beta_3 - \beta_4)$
α = Private returns to physical capital	$\alpha = \beta_2 + \beta_3 + \beta_4$, if $\phi = 1$
λ = externality effect of physical capital	$\lambda = (\beta_2 + (\beta_3 + \beta_4)\phi) - \alpha)/(1 - \phi)$
ϕ = Parameter of congestion effect	In the range of (0 - 1]
3) STABILITY OF THE GROWTH MODEL	3) TEST FOR PERPETUAL BUT NON-EXPLOSIVE GROWTH
Neoclassical	$\alpha + (\lambda + \varphi + \eta)(1 - \phi) < 1, \lambda > 1$
Endogenous	$\alpha + (\lambda + \varphi + \eta)(1 - \phi) = 1, \lambda = 0$
Speed of Adjustment of Output to Disequilibrium	Estimation of ECM & short run dynamics

Table 2: Statistics for selecting the lag order of the ECM

lag	logL	LR	FPE	AIC	SC	HQ
0	149.10	NA	2.78e-08	-6.05	-5.40	-5.8
1	424.17	450.11	2.17e-13	-17.83	-16.53*	-17.34
2	447.13	33.40	1.64e-13	-18.14	-16.19	-17.42
3	462.44	19.48	1.84e-13	-18.11	-15.51	-17.15
4	486.32	26.05	1.49e-13*	-18.47	-15.22	-17.26
5	506.09	17.98	1.60e-13	-18.64	-14.74	-17.20
6	546.61	29.46*	7.81e-14*	-19.76*	-15.21	-18.07*

Table 3:The Estimated Short Run Dynamics and Adjustment Coefficient of the ARDL (0,1,2,3)

| variable	estimated coefficient (standard errors)
$\triangle \ln k_{t-1}$	0.22**(0.10)
$\triangle \ln h_t$	0.22*(0.12)
$\triangle \ln h_{t-1}$	-0.07(0.1)
$\triangle \ln o_{t-1}$	0.06**(0.02)
$\triangle \ln o_{t-2}$	0.02(0.02)
D01	-0.13**(0.02)
DIN	-0.02**(0.01)
DO	-0.008(0.008)
C	0.025**(0.005)
ECM(-1)	-0.11**(0.04)
R-squared	0.71
Adjusted R-squared	0.64
SE of Regression	0.017
Sum of squared residual	0.01
Log likelihood	131.1
Durbin-Watson stat	2.17
Mean dependent var	0.027
SD dependent Var	0.028
Akaike information criterion	-5.15
Schwarz criterion	-4.76
Hannan-Quinn criterion	-5.01
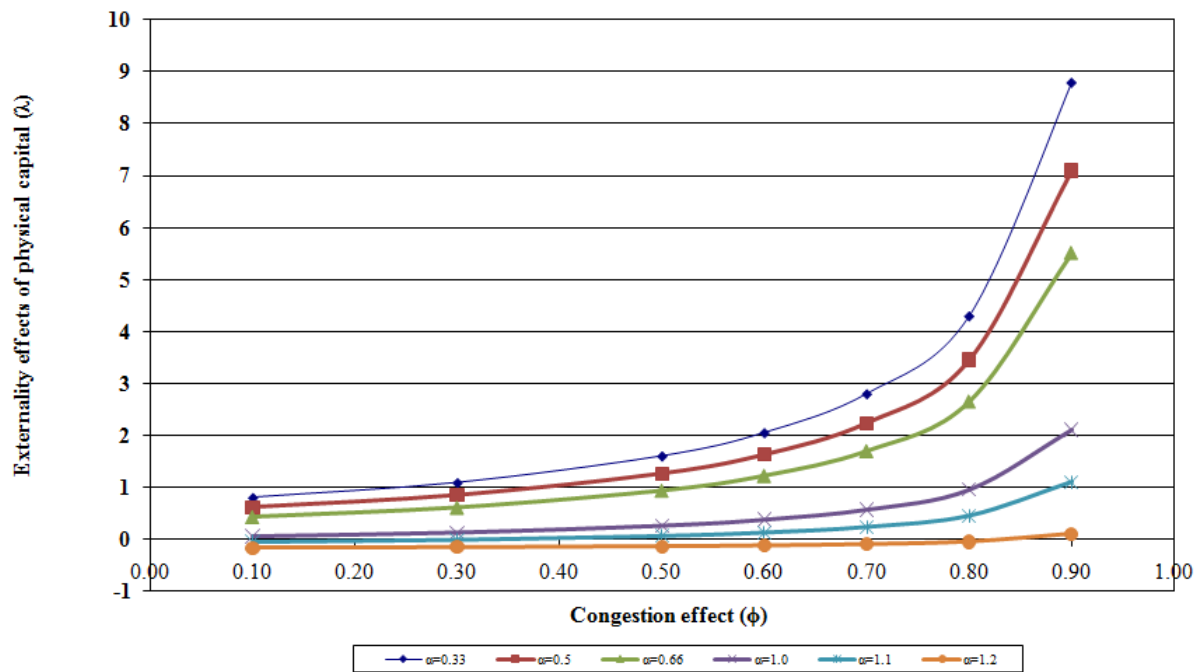
Figure 1: Recovered values for the externality effect of physical capital for different combinations of private returns to physical capital (α) and congestion effect (ϕ)

Appendix

A. Derivation of equation (8)

We start from equation (6), which is repeated for convenience:

$$y_{jt} = Ak_{jt}^\alpha (1+\gamma)^t l_{jt}^{(1-\alpha)} \tilde{K}_t^\lambda \tilde{H}_t^\varphi \tilde{O}_t^\eta \varepsilon_t^p$$

substitute equations for congestion effects:

$$y_{jt} = A(1+\gamma)^t l_{jt}^{(1-\alpha)} k_{jt}^\alpha \left(\frac{K_t}{K_t^\phi \left[(1+\gamma)^t L_t \right]^{1-\phi}} \right)^\lambda \left(\frac{H_t}{K_t^\phi \left[(1+\gamma)^t L_t \right]^{1-\phi}} \right)^\varphi \left(\frac{O_t}{K_t^\phi \left[(1+\gamma)^t L_t \right]^{1-\phi}} \right)^\eta \varepsilon_t^p$$

(17)

The aggregate variables in per efficiency unit (lab our of a person adjusted for his/ her efficiency) can be expressed as:

$$k_t = \frac{K_t}{(1+\gamma)^t L_t}, h = \frac{H_t}{(1+\gamma)^t L_t}, o_t = \frac{O_t}{(1+\gamma)^t L_t},$$

(18)

substitute these equations and express equation (17) in per efficiency unit:

$$\hat{y}_{jt} = Ak_{jt}^\alpha \left(\frac{k_t}{k_t^\phi \left[\frac{(1+\gamma)^t L_t}{(1+\gamma)^t L_t} \right]^{1-\phi}} \right)^\lambda \left(\frac{h_t}{K_t^\phi \left[\frac{(1+\gamma)^t L_t}{(1+\gamma)^t L_t} \right]^{1-\phi}} \right)^\varphi \left(\frac{o_t}{k_t^\phi \left[\frac{(1+\gamma)^t L_t}{(1+\gamma)^t L_t} \right]^{1-\phi}} \right)^\eta \varepsilon_t^p$$

(19)

$$\hat{y}_{jt} = Ak_{jt}^\alpha \left(\frac{k_t}{k_t^\phi} \right)^\lambda \left(\frac{h_t}{K_t^\phi} \right)^\varphi \left(\frac{o_t}{k_t^\phi} \right)^\eta \varepsilon_t^p$$

(20)

which results in equation (8)

$$\hat{y}_{jt} = Ak_{jt}^\alpha k_t^{\lambda - \phi(\lambda + \varphi + \eta)} \hat{h}_t^\varphi \hat{o}_t^\eta \varepsilon_t^p$$