

Economic Consequences of War: Evidence from Sri Lanka

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Abstract

We propose a theoretical and econometric framework to evaluate the impact of war on economic growth of a developing country with an open economy. The theoretical framework encompasses both the neoclassical and endogenous growth models. The econometric model is derived from the theoretical framework and an Autoregressive Distributed Lag framework is used for the estimation. We test this framework using Sri Lankan data. The war had significant and negative effects both in the short and long-run (annual average of 9% of GDP). High returns from investment in physical capital did not translate in sizable positive externalities. No significant effects of openness on growth in the long-run are found; however, effects are significant in the short-run. Inconsistent politically driven policies towards openness are the likely reason. As the ethnic conflict has finally come to an end, a policy framework with appropriate institutional reforms is needed for rapid growth and development.

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1 Introduction

During the past few decades many developing countries have faced conflict within their own borders. These have taken the form of civil war often related to ethnic conflicts or boarder disputes. In this paper a theoretical model and a derived econometric framework are proposed for the case of a developing country with an open economy at war. Sri Lanka will be used to estimate the model in this paper; however, the framework is general and can be applied to other developing economies suffering from conflict. The model is a modified version of Lau and Sin (1997a) common framework for the neoclassical and Romer's growth models. This framework was generalized by

Lau and Sin (1997b) to analyze public infrastructure and by Ganegodage and Rambaldi (2011) to study investment in public tertiary education. In this study, we extend this framework to an open economy in war.

The literature on the effects of war on economic growth, both theoretical and empirical, shows mixed results (Blattman and Miguel, 2010; Gyimah-Brempong and Corley, 2005). The evidence from annual growth rates is similarly mixed. Sri Lanka enjoyed a 5% annual growth rate on average (with the exception of 2001) over the 30 year period of its civil conflict (1983-2008), while many other developing countries with similar civil unrest such as Afghanistan, Burundi and Somalia have failed to achieve such an outcome (Snodgrass, 2004; Wijeweera and Webb, 2009). It is the contention of this paper that even when measures of economic performance show a net positive effect, war is unlikely to have had a positive contribution to economic growth in the case of a developing country that does not produce military hardware for the market.

War and Economic Growth: Theory and Empirical Evidence

The theoretical literature on the effects of civil conflict on economic growth provides two contrasting views. The first view is backed by Benoit's popular hypothesis (Benoit, 1973; 1978) which states war affects positively economic growth and development. This hypothesis which is in line with Keynesian economic theory argues that military expenditure can be treated as expansionary fiscal policy that can stimulate the economy by increasing aggregate demand and creating positive externalities. According to this view, military expenditures not only increase and improve infrastructure, employment and production but also increase the skills of the workforce and the technological development through military specific training and competencies. Using the European history experience, some scholars claim that war plays a critical role in developing strong institutions (Blattman and Miguel, 2010; Tilly, 1975). Therefore, war would result in positive growth and development in the long run. By contrast a second school of thought argues that war damages the economy through the destruction of resources and by reducing investment (World Bank, 2003). More importantly, expenditures in war activities have a high opportunity cost (Galvin, 2003) as it crowds-out investment in other areas such as education, health and infrastructure. Further, ongoing war activities not only crowd out investment in other areas but also hamper foreign direct investment by which many developing countries, such as Sri Lanka, can find an easy path to improve economic performance.

The empirical literature on the effect of war has been in three main directions. The first group tries to estimate the cost of war using an accounting framework on which the budgetary costs of military expenditure, in the form of decreased taxation revenues, and the cost of the destroyed infrastructure are taken into account (Collier et al., 2003; FitzGerald et al., 2001). The second group compares the performance of countries affected by conflict against a benchmark. The benchmark country can be a non-conflict country (Stewart et al., 2001) or an artificially created benchmark (Abadie and Gardeazabal, 2003). The third group employs regression based approaches (Blomberg et al., 2004; Cerra and Sexena, 2008; Collier, 1999). These regression based approaches can be divided into two main groups, namely, demand and supply based approaches. The demand based approaches are mainly empirical

models of the Benoit hypothesis of war (Wijeweera and Webb, 2009; 2010). There are several supply side approaches; among them, the Feder and Ram models are prominent (Biswas and Ram, 1986). They are similar to a Lucas dual economy model; one sector is for military production and the other represents the civilian production. These models do not suit developing economies well as they assume there is a sector that produce military hardware for the market. There are other supply side approaches based on unified growth models which are more suitable as they overcome some of the shortcomings of the demand based approach and the Fed and Ram model (Blattman and Miguel, 2010; Collier, 1999; Murdoch and Sandler, 2002).

The most dominant group of empirical studies on the effect of war on growth are cross-country studies while a few country-specific studies are available (Blattman and Miguel, 2010). While some of these studies found positive significant effects of war on growth (Stewart, 1991; Yildirim et al., 2005) others found significant and negative effects on growth (Collier, 1999; Gyimah-Brempong and Corley, 2005). In some cases the effects are found to be short term (Murdoch and Sandler, 2002).

Measuring the effect of war is a non-trivial problem. A number of measures have been used as proxies for war. Among them, dummy variables (Chen et al., 2008), death or casualties (militant) of war per year (Gyimah-Brempong and Corley, 2005; Murdoch and Sandler, 2002) and military expenditure as a percentage of GDP (Wijeweera and Webb, 2009; 2010) to name a few that are prominent. All of these alternative measures suffer from some limitations. For instance, dummy variables cannot be used to assess the long-run impact of war on growth. The number of military casualties during a war is not suitable as this is a poor measure of the number of civilian casualties in within-boarders conflicts as it is the case of Sri Lanka. In addition, measures of war casualties are sensitive for parties who have engaged in the conflict and thus they are in general prone to manipulation and not systematically available. In the case of many countries, including Sri Lanka, there are no annual figures. In an effort to improve reliability, this study constructs an index to capture the "war effort." The index measures war effort as a share of the labor force. The measure is an "adjusted" share of the population in the armed forces to that in the labor force. It is adjusted by the share of military expenditures to GDP (details provided in Section 3.1).

The rest of the paper is organized as follows. The next section presents the theoretical framework and derived econometric model. Section 3 presents the empirical implementation of the model to the case of Sri Lanka. The final section provides a summary and conclusions of the study.

2 The Framework

2.1 Theoretical Model

We consider an open economy with N (large) number of identical agents, the government, and an inelastically supplied labor input. The consumption of an agent (household/firm) of this economy (to choose $\{c_t, k_{t+1}\}_{t=0}^{\infty}$ to maximize utility) is given by:

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t \ln c_{jt} \right] \quad (1)$$

where,

$E_t()$ and, c_{jt} are the expectation operator conditional on the information set at time t and the consumption level of agent j ($j = 1, \dots, N$) at time t , respectively; $\beta \in (0, 1)$ is the discount factor.

The resource constraint of the economy is given as:

$$Y_t = C_t + I_t + G_t + X_t - M_t \quad (2)$$

where,

Y_t, C_t, I_t, G_t, X_t and M_t are the aggregate level of output, consumption, investment expenditures, government expenditures, imports and exports at time t , respectively; and $X_t - M_t = 0$

Government expenditures are assumed to be financed by a proportional income tax and the budget is balanced every period. Therefore:

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

At time t , the agent's production function in Cobb Douglas is written as:

$$y_{jt} = Ak_{jt}^\alpha \left[(1 + \gamma)^t l_{jt} \right]^{1-\alpha} \tilde{K}_t^\lambda \tilde{W}_t^\omega \tilde{O}_t^\varphi \varepsilon_t^p \quad (3)$$

$t = 1 \dots T, A > 0, 0 \leq \alpha, \gamma \geq 0, \lambda, \varphi, \omega < 1$

where,

y_{jt}, k_{jt} and l_{jt} denote output, physical capital, and labor inputs of agent j at time t , respectively.

The function in equation (3) is constant returns to scale with respect to the capital and labor inputs of the agent; α is private returns to physical capital while the externality effects due to physical capital, war activities and openness of the economy are denoted by λ, ω and φ , respectively¹. ε_t^p is a random productivity shock in period t .

\tilde{K}, \tilde{W} and \tilde{O} are congestion adjusted available physical capital, war activities and openness at aggregate level at time t , respectively. Congestion is created when the resources are allocated for physical capital, war activities and openness. Eicher and Turnovsky (2000) described two types of congestion, namely, relative congestion and aggregate congestion. Relative congestion is the level of services derived by an individual from the provision of a public good in terms of the usage of their individual capital stock relative to the aggregate stock. Aggregate congestion refers to how the aggregate usage of the service along influences the services received by the individual.

In this model the congestion effect is assumed to be of the same form for all variables and given by:

¹Due to the investment in physical capital, there are private returns to firms and social returns to the society, i.e externality effects of physical capital.

$$\begin{aligned}\tilde{K}_t &= \frac{K_t}{K_t^\phi [(1+\gamma)^t L_t]^{1-\phi}}, \tilde{W}_t = \frac{W_t}{K_t^\phi [(1+\gamma)^t L_t]^{1-\phi}}, \\ \tilde{O}_t &= \frac{O_t}{K_t^\phi [(1+\gamma)^t L_t]^{1-\phi}}\end{aligned}\quad (4)$$

where,

$0 \leq \phi \leq 1$. K_t , W_t and O_t are respectively the aggregate levels of physical capital stock, war activities and openness.

The productivity impulses are modeled as an autoregressive stochastic process without a drift. i.e:

$$\ln \varepsilon_t^p = \zeta \ln \varepsilon_{t-1}^p + v_t^p \quad (5)$$

where, $0 \leq \zeta \leq 1$, v_t^p is a white noise process.

Substituting the congestion effects (4) into the production function given in equation (3)

$$\begin{aligned}y_{jt} &= Ak_{jt}^\alpha [(1+\gamma)^t l_{jt}]^{1-\alpha} \left(\frac{K_t}{K_t^\phi [(1+\gamma)^t L_t]^{1-\phi}} \right)^\lambda \left(\frac{W_t}{K_t^\phi [(1+\gamma)^t L_t]^{1-\phi}} \right)^\omega \\ &\quad \left(\frac{O_t}{K_t^\phi [(1+\gamma)^t L_t]^{1-\phi}} \right)^\varphi \varepsilon_t^p\end{aligned}\quad (6)$$

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

$$\bar{k}_t = \frac{K_t}{(1+\gamma)^t L_t}, \bar{w}_t = \frac{W_t}{(1+\gamma)^t L_t}, \bar{o}_t = \frac{O_t}{(1+\gamma)^t L_t} \quad (7)$$

Substitute these equations and express equation (6) in per 'efficiency unit' to obtain (10):

$$\begin{aligned}\bar{y}_{jt} &= A\bar{k}_{jt}^\alpha \left(\frac{\bar{k}_t}{\bar{k}_t^\phi \left[\frac{(1+\gamma)^t L_t}{(1+\gamma)^t L_t} \right]^{1-\phi}} \right)^\lambda \left(\frac{\bar{w}_t}{\bar{k}_t^\phi \left[\frac{(1+\gamma)^t L_t}{(1+\gamma)^t L_t} \right]^{1-\phi}} \right)^\omega \\ &\quad \left(\frac{\bar{o}_t}{\bar{k}_t^\phi \left[\frac{(1+\gamma)^t L_t}{(1+\gamma)^t L_t} \right]^{1-\phi}} \right)^\varphi \varepsilon_t^p\end{aligned}\quad (8)$$

$$\bar{y}_{jt} = A \bar{k}_{jt}^\alpha \left(\frac{\bar{\kappa}_t}{\bar{\kappa}_t^\phi} \right)^\lambda \left(\frac{\bar{w}_t}{\bar{\kappa}_t^\phi} \right)^\omega \left(\frac{\bar{o}_t}{\bar{\kappa}_t^\phi} \right)^\varphi \varepsilon_t^p \quad (9)$$

which results in equation (10)

$$\bar{y}_{jt} = A \bar{k}_{jt}^\alpha \bar{\kappa}_t^{\lambda - (\lambda + \omega + \varphi)\phi} \bar{w}_t^\omega \bar{o}_t^\varphi \varepsilon_t^p \quad (10)$$

where,

\bar{y}_t , $\bar{\kappa}_t$, \bar{w}_t , and \bar{o}_t , denote respectively, the level of output, physical capital, war activities and openness per efficiency unit at t ; \bar{k}_{jt} denotes the individual's capital.

At equilibrium $\bar{\kappa}_t = \bar{k}_{jt}$.

Thus:

$$\bar{y}_t = A \bar{k}_t^{(\alpha + \lambda - (\lambda + \omega + \varphi)\phi)} \bar{w}_t^\omega \bar{o}_t^\varphi \varepsilon_t^p \quad (11)$$

Equation (11) is for endogenous growth as $\gamma = 0$. If growth were exogenous, γ would represent the rate of technical progress. Expressing the function in per capita terms, exogenous growth can be made explicitly. Substitute the equations for congestion effects (4) into the production function (3):

$$y_{jt} = A [l_{ij}(1 + \gamma)^t]^{(1 - \alpha)} k_{jt}^\alpha \left(\frac{K_t}{K_t^\phi [(1 + \gamma)^t L_t]^{1 - \phi}} \right)^\lambda \left(\frac{W_t}{K_t^\phi [(1 + \gamma)^t L_t]^{1 - \phi}} \right)^\omega \left(\frac{O_t}{K_t^\phi [(1 + \gamma)^t L_t]^{1 - \phi}} \right)^\varphi \varepsilon_t^p \quad (12)$$

We can rearrange to express aggregate variables in per capita terms:

$$\kappa_t = \frac{K_t}{L_t}, \quad w_t = \frac{W_t}{L_t}, \quad o_t = \frac{O_t}{L_t} \quad (13)$$

Substituting these equations and expressing equation (12) in per capita ($l_{ji} = 1$):

$$y_{jt} = A [(1 + \gamma)^t]^{(1 - \alpha)} k_{jt}^\alpha \left(\frac{\kappa_t}{\kappa_t^\phi \left[\frac{(1 + \gamma)^t L_t}{L_t} \right]^{1 - \phi}} \right)^\lambda \left(\frac{w_t}{\kappa_t^\phi \left[\frac{(1 + \gamma)^t L_t}{L_t} \right]^{1 - \phi}} \right)^\omega \left(\frac{o_t}{\kappa_t^\phi \left[\frac{(1 + \gamma)^t L_t}{L_t} \right]^{1 - \phi}} \right)^\varphi \varepsilon_t^p \quad (14)$$

$$y_{jt} = A[(1 + \gamma)^t]^{(1-\alpha)} k_{jt}^\alpha \left(\frac{\kappa_t}{\kappa_t^\phi [(1 + \gamma)^t]^{(1-\phi)}} \right)^\lambda \left(\frac{w_t}{\kappa_t^\phi [(1 + \gamma)^t]^{(1-\phi)}} \right)^\omega \left(\frac{o_t}{\kappa_t^\phi [(1 + \gamma)^t]^{(1-\phi)}} \right)^\varphi \varepsilon_t^p \quad (15)$$

At equilibrium $\kappa_t = k_{jt}$.

Therefore, in per capita terms

$$y_t = A \kappa_t^{(\alpha + \lambda - (\lambda + \omega + \varphi)\phi)} (1 + \gamma)^{t(1 - \alpha - (1 - \phi)(\lambda + \omega + \varphi))} w_t^\omega o_t^\varphi \varepsilon_t^p \quad (16)$$

where,

y_t , κ_t , w_t and o_t are, the level of output, physical capital, war activities and openness per capita at t , respectively.

2.2 Derived Econometric Model

If growth is endogenous it is created as a result of a positive externality effect of physical capital; therefore, $\gamma = 0$, $\lambda > 0$, random productivity shocks are $I(0)$, and thus all log variables are difference stationary and the order of integration of the log form of the variable is at most one, $\alpha + (\lambda + \omega + \varphi)(1 - \phi)$ should equal to 1 and all external impulse processes, random productivity shocks due to physical capital, war and openness should be $I(0)$. For exogenous growth $\gamma > 0$ and $\lambda = 0$, $\alpha + (\lambda + \omega + \varphi)(1 - \phi) < 1$, 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, the variables are trend stationary.

Linearizing (16) by taking logarithm gives equation (17)²:

$$\ln y_t = \beta_2 \ln k_t + \beta_3 \ln w_t + \beta_4 \ln o_t + \beta_5 t + \ln \varepsilon_t^p \quad (17)$$

where,

$$\beta_2 = \alpha + \lambda - [(\lambda + \omega + \varphi)\phi], \beta_3 = \omega, \beta_4 = \varphi, \beta_5 = \gamma(1 - \alpha - [(1 - \phi)(\lambda + \omega + \varphi)]) \quad (18)$$

This linearized version allows the evaluation of the theoretical model in (16) on issues such as whether data are consistent with endogenous or exogenous growth as well as the effect of war on economic growth.

Estimation of the reduced form in (17) will not allow the recovery of all structural parameters. The parameter of private returns to physical capital (α) and that of the externality effect of physical capital (λ) are functions of the estimated coefficients for other variables (see (18)), war and openness, and the parameter of the congestion effect. The externality effect of physical capital, λ is given by:

$$\lambda = [\beta_2 + ([\beta_3 + \beta_4] \phi) - \alpha] / (1 - \phi) \quad (19)$$

² $\ln(1 + \gamma)$ is approximated by γ as we assume γ is small.

Note that when $\phi = 1$, $\alpha = \beta_2 + \beta_3 + \beta_4$ and λ cannot be identified. However, it provides an upper bound for the parameter α (private return to physical capital). Thus, we calibrate a feasible range of values for λ using a range of values within the feasible parameter space for α and ϕ . As observed by other studies the returns to physical capital, α , are higher for less developed countries (Tallman and Wang, 1994). In the empirical section this is discussed in more detail and the estimates using Sri Lankan data are presented.

The testing and estimating the growth model in (16) is conducted by employing the Autoregressive Distributed Lag (ARDL) approach (Bound testing approach) proposed by Pesaran et al. (2000; 2001). There are several advantages of using this approach over the conventional method, the Johansen procedure. More importantly, this method does not require pre-testing for unit roots of individual regressors³ which is still highly questionable; therefore this approach is more efficient (Baharumshah et al., 2009; Fosu and Magnus, 2006). A second reason to use this approach is that it allows us to use different number of lags for different variables which is restricted in the other approaches including the Johansen procedure. In addition, the cointegration analysis can be implemented for shorter time series as in the case of our study, as Narayan (2005) has developed critical values for samples as small as 30 observations.

This section has presented a theoretical and econometric framework suitable for the analysis of the effect of war on economic growth. Table 1 summarizes and maps the links between the theoretical framework and the econometric approach at each stage of the study.

[Table 1 here]

3 The Case of Sri Lanka

Over the past 30 years, the war in Sri Lanka between the government forces and the armed militant group named “the Liberation Tigers of Tamil Eelam (LTTE)” has been a prominent part of its people’s life and economy. The number of deaths is estimated at over 70,000 and around 5 percent of the population was displaced (Kuhn, 2009). However, unlike the case of many other developing countries, by end of May 2008, the Sri Lankan government ended this armed conflict using its own military power.

Sri Lanka is classified by the World Bank as a middle-income-group country (World Bank, 2011). Its population is of around 20 million and it is a small multi-ethnic country. The two main ethnic groups are Sinhalese and Tamils; the Sinhalese community forms the majority of its population comprising over 75%; the Tamils, who are concentrated in the North and East of the island, form the largest ethnic minority comprising around 18% of the population. The declaration of Sinhalese as the official language by the government in the 1960s led to ethnic tensions and conflicts between Tamils and Sinhalese as Tamils believed they had been discriminated by the government as well

³However, we have to verify that the variables are not I(2).

as by the Sinhalese majority (Arunatilake et al., 2001; Sharif, 2011)⁴. Tensions between Tamils and the government intensified in the late 1970s with the formation of several armed militant groups within the Tamil community. This led to a brutal civil war which earned the title of “Asia’s longest war” in later years. By the 1990s, the group, LTTE, which was founded in 1976, became the only group directly fighting with the Sri Lankan government as it was able to suppress other armed militant Tamil groups. At the highest point of their power, it possessed a well-developed militia and was able to control over 75% of the land in the Northern and Eastern Provinces of the country. The LTTE was able to build its own police, army, navy forces as well as an air force with a few light aircraft. More importantly, it had a well trained suicide carder which was responsible for conducting several assassinations including the killings of a president of Sri Lanka, a well known prime minister of India, Rajiv Gandhi, as well as many powerful government and opposition political leaders and higher ranked military commanders in Sri Lanka. The suicide attacks and powerful bombs targeted many public places and strategic economic as well as security hubs in other parts of the country, mainly in the capital, Colombo. During this period, there were four failed attempts at peace talks including one attempt with direct Indian intervention which led to the deployment of the Indian Peace Keeping Force from 1987 to 1990. Apart from this ethnic war, the country experienced two youth uprisings in 1971 and 1987-1989 launched by Sinhalese youth in the southern part of the country against the government which created many disruptions to the community.

Because of the war, Sri Lanka’s military spending as a percentage of GDP, increased from 1.6 percent in 1983 to 3.5 in 2008. It reached its peak at 5.9 percent of GDP in 1995, a figure that represents over 20 percent of total government spending. Before 1983, arm imports were not a regular practice of the Sri Lankan government. However, from 1984, arms were imported annually; in the year 2000, the government’s import bill for arms was around \$US 274 million (constant 1990), the highest reported spending on weapons during the war period. Spending on military activities in Sri Lanka is greater than that of many countries in the South Asian region (such as India, Bangladesh and Nepal). Similarly the number of defense personnel increased by almost ten fold from 22,000 in 1989 to 213,000 in 2008.

A few studies of the war in Sri Lanka are available. Some of them have been descriptive (Arunatilake et al., 2001; Grobar and Gnanaselvam, 1993; Kelegama, 1999). Arunatilake et al. (2001) estimated the direct and indirect cost of war, and estimated the accumulated loss from 1983 to 1996 to be equivalent to over 160 percent of the GDP in 1996 using a constant interest rate of 5 percent. The direct costs include reduction in nonmilitary expenditure and damage to infrastructure while the major portions of indirect costs consist of income loss from foregone investment, reduced tourism and loss of human capital through death and injury, displacement of people and output forgone in the war zone. Grobar and Gnanaselvam (1993) showed that the war significantly reduced the investment flow into the country and therefore concluded that the war could have long run implications for the country’s economy. Using the incremental capital output ratio and drop in investment GDP ratio they calculated a loss of around

⁴As noted by Grobar and Gnanaselvam (1993), the conflicts between these two ethnic groups has a long history and it dates back to 150 B.C.

20 percent of GDP during 1983-1988. Using time series techniques, Wijeweera and Webb (2009; 2010) tested the popular Benoit hypothesis of the relationship between military spending and economic growth using four variables; military and nonmilitary expenditure as a percentage of GDP, per capita income and interest rate. Following many other prominent studies, they employed a version of a Keynesian model to assess the impact. The study covered the period 1976 to 2007. The econometric approach employed was a VAR from which impulse response functions were estimated. In the 2010 paper, they extend this approach to a cointegration framework. Neither of these studies finds a sizable significant effect of military expenditure on growth; however, in the 2010 paper they found a positive impact of non military expenditure on long run growth. These insignificant results may be due to their specific theoretical approach and the variables chosen to represent war activity. As acknowledged by Wijeweera and Webb (2009), the available data on military expenditure are prone to manipulation due to political sensitivities.

3.1 Variables and Data Used in This Study

Researchers have long debated over the short run vs long run effects of conflicts, endogeneity between the conflicts and growth, as well as over the recovery of factors of production, in particular physical capital, to the equilibrium level in war torn countries (Blattman and Miguel, 2010; Murdoch and Sandler, 2002; Wijeweera and Webb (2010)). The framework adopted in this study treats variables as endogenous. The war period was from 1983 to 2008 and the analysis in this study covers the period 1960-2008. During the study period, the openness of the Sri Lankan economy has varied. From 1956, as the political power shifted to an anti western group, the country tasted import substituting economic policies to overcome unemployment and balance of payment difficulties. From 1965-1970, the political power changed to a pro-western group and the government attempted to introduce more liberalized policies in 1968; however, it failed due to the popularity of anti western ideologies. During 1972-1976, the political power again changed to a group with leftist political ideologies which adopted tighter policies to ease the effects of the oil shock (Athukorala and Rajapatirana, 2000). In 1977 a new regime with pro-western ideas came to power and introduced a liberalization program to improve the economic performance through attracting foreign investment. This liberalization framework has been continued until now with minor changes, though the political power changed from time to time. These changes in economic policies are taken into consideration in this study. However, due to limited data availability, we cannot include any institutional variable although we recognize their importance in studying growth performance during conflicts (Blattman and Miguel, 2010).

The model consists of four main variables namely output (GDP), physical capital, war and openness which are expressed in per labor unit. Though GDP data can be obtained directly from available sources, data on all other variables are not directly available. Therefore, the variables, except GDP, are constructed or proxied by other suitable variables. Using investment data the capital stock data series was estimated by the perpetual inventory formula used in Binder and Pesaran (1996) with a 4% depreciation rate. To construct a measure of “war effort,” we combine two variables, the ratio of the number of personnel in the armed forces to the number of people in

the labor force and the military expenditure as a ratio of GDP. The expenditure in military activities are readily available from the World Bank and the Central Bank of Sri Lanka. The number of people in the arm forces are not readily available for some years. Therefore, the series was constructed using information from various formal (e.g. the World Bank) and informal sources such a newspaper articles taken from briefings from the Ministry of Defence in Sri Lanka. We employ these two measures to construct an index of war effort. The estimated index of war effort, \hat{w}_t , is measured as an adjusted (by defense expenditures) measure of the proportion of people in the armed forces compared to those in the country's labor force. Specifically, the index is given by the predictions from the following multiple regression model,

$$\ln(\text{arm}_t) = \alpha + \delta_1 \ln(\text{milex}_t) + \delta_2 \ln(\text{arm}_{t-1}) + \delta_4 D77 + \epsilon_t \quad (20)$$

$$\hat{w}_t = \exp(\ln(\widehat{\text{arm}}_t)) \quad (21)$$

where, *milex* is government expenditures on defense activities as a ratio of GDP; *arm* is the ratio of the number of personnel in the armed forces to the number of people in the labor force; D77 is a dummy for the period 1977-2008 when more open economic policies were pursued. Table 2 presents the estimates of model in equation (20) and Figure 1 presents the predicted war effort index (\hat{w}_t).

[Table 2 here]

[Figure 1 here]

It is clear from the figure that from 1980 to 2000 the war effort grew exponentially to close to 2% of the labor force and remained relatively stable until the end of the conflict in 2009. The index is used as one of the variables in the econometric model.

The variable \hat{w}_t is known as a generated regressor in econometric theory (Pagan, 1984). The asymptotic variance of the OLS estimator is heteroskedastic and requires adjustment when generated regressors are included (Oxley and McAleer, 1993; Wooldridge, 2002). The generated regressor problem does not arise (at least asymptotically) in the estimation of parameters in a cointegrating regression due to the super-consistency of the OLS estimator in this case (for a discussion see McAleer et al. (1994)). The limiting distribution of the Wald statistic used in this study to test for cointegration (i.e. the Autoregressive Distributed Lag bound tests of Pesaran et al. (2001)) has T-convergence as well (see Theorem 4.3).

The working age population, 20-64 years, is used as a proxy for the labor force as a continuous set of published data is not available. In addition, we employed several dummy variables: DO1 to represent the economic slow down of 2001 due to an electricity crisis combined with intensification of the war, DO to represent the period with most inward looking economic policies and D77 to present the period with more outward economic policies. These were

gathered from various issues of the Annual Reports of the Central Bank of Sri Lanka (Sri Lanka Central Bank, various years; 1998), World Development Indicators (WDI) and many other sources including newspaper articles. The empirical estimation is presented in the next section.

3.2 Empirical Results

The econometric model is estimated by implementing Pesaran et al. (1999; 2001). The Bounds Test of Pesaran et al. (2001) is used to test for a valid long-run relationship. If cointegration is found, the model is estimated using an ARDL representation following Pesaran et al. (1999). The Bounds test is conducted on a conditional autoregressive distributed lag form:

$$\begin{aligned} \Delta \ln y_t = & \beta_0 + \beta_1 \ln y_{t-1} + \beta_2 \ln k_{t-1} + \beta_3 \ln \hat{w}_{t-1} + \beta_4 \ln o_{t-1} + \beta_5 t + \sum_{i=1}^p \delta_{yi} \Delta \ln y_{t-1} + \sum_{i=0}^p \delta_{ki} \Delta \ln k_{t-1} \quad (22) \\ & + \sum_{i=0}^p \delta_{wi} \Delta \ln \hat{w}_{t-1} + \sum_{i=0}^p \delta_{oi} \Delta \ln o_{t-1} + \ln \varepsilon_t^p \end{aligned}$$

where Δ denotes the first differences and all variables are expressed in log form, output ($\ln y$), physical capital ($\ln k$), war effort ($\ln \hat{w}$) and openness ($\ln o$).

The Bounds test is a cointegration test for the null hypothesis, $H_0 : \beta_1 = 0$ and $\beta_2, \beta_3, \beta_4 = 0$ in (22). The test involves the comparison of the F-statistics against the critical values which are generated for specific sample sizes. In this paper we use the critical values generated by Narayan (2005). To determine the value of p , we test up to a maximum lag length of 5 as the sample size is limited. Table 3 provides AIC, BIC and two LM statistics for testing for residual correlation of orders 1 to 5.

[Table 3 here]

The evidence for exogenous/endogenous growth is assessed by including a time trend (non-zero deterministic trend) within the cointegrating relationship (see equation (17)) in the ARDL model (see 22) and conducting the Bounds test in the ARDL models with and without the time trend. The computed F value when the time trend is included is 4.59 which is greater than the upper bound of the critical value provided by Narayan (2005, p.1989) for $n=50$ (critical value bounds at 5 percent: 3.05 for $I(0)$, 3.97 for $I(1)$). However the time trend is not significant ($\beta_5 = \gamma$). The calculated F statistics for the existence of a long run vector in the equation without the time trend is 5.04 (the critical values for the lower bound $I(0)$ and the upper bound $I(1)$ at the 5% level are respectively 2.86 and 4.01 (Narayan 2005 p. 1988)). These results indicate the existence of cointegration in the model without a time trend. These findings indicate the model is consistent with an endogenous growth model.

The next step is to estimate the long run relationship (for the levels) and short run dynamics. Here we follow Pesaran and Shin 1999, and find the most parsimonious model for the Sri Lankan data to be an ARDL(3,1,3,5).

This model is used for further testing and estimation.

The estimated speed of adjustment and the short run dynamics are presented in Table 4. The estimated long run relationship (standard errors in parentheses) is given as:

$$\widehat{\ln y_t} = 1.27 \ln k_t - 0.09 \ln \hat{w}_t + 0.25 \ln o_t \quad (23)$$

(0.16) (0.04) (0.20)

[Table 4 here]

The estimated coefficients of the above long run relationship are significant at the 5% level and yield expected signs except for the openness measure (details shortly). Many coefficients in the short run equation are significant at either the 5 or 10 percent level. The estimated adjustment coefficient is small in magnitude (-0.26) indicating that adjustment back to equilibrium from a shock to output is slow (approximately 4 years to recover). The estimates of the coefficients of the dummy variables are significant at least the 10 percent level and with expected signs.

Our main interest is on the war measure. We find the effect of war on output is negative. The coefficient estimate implies that one percent increase in the "war effort", as measured by \hat{w}_t - an adjusted share of involvement in the armed forces (in relation to the labor force), would result in approximately 0.09 percent reduction in output in the long run. In addition, the estimates of the short run coefficients are significant at either the 5% or 10% and some with expected negative signs. Therefore our results imply that there have been negative impacts from the war on the Sri Lankan economy both in the short as well as in the long run. We note that \hat{w}_t increased from 0.001 in 1980 to approximately 0.02 by 2000 with an exponential increase between 1985 and 2000 (see Figure 1). According to Grobar and Gnanaselvam (1993), on average, there was around 4 percent annual loss in output during the early stages of the war. During the later stages, when the war reached its peak, the loss of output would have been much higher than the estimate of Grobar and Gnanaselvam (1993). Richardson and Samarasinghe (1991) estimated around 60 percent loss of GDP in 1988 for the same time period. On average that is around 10 percent annual loss in output which would be higher for the early stages of war. This is very close our figure. The study by Arunatilake et al. (2001) projected the total output loss during 1988 -1996 using three levels of interest rates, zero rate, 5 and 10 percent. Their calculations are that the average annual GDP loss ranges from almost 12 to 17 percent which are relatively high compared to our estimate. However, both projections are not from a direct assessment of war effort on economic growth using advanced econometric techniques. Using an estimate for the loss of growth rate due to war through a cross country regression, Collier (1999) and Hoeffler and Reynal-Querol (2003) estimated around 15 percent of annual output loss for a hypothetical country in a war. Therefore our estimate of around 9 percent loss is reasonable.

The estimated coefficient of the openness measure $\beta_4 = \varphi$ is not significant. However, all short run coefficient

estimates are significant and some of them have negative signs. This variable captures a range of policies. During the sample period these ranged from inward looking and highly regulated to more liberalized. Thus, the results seem not surprising and are similar to those of previous studies. The inward-looking, import-substitution policies during 1960-1977 period led to an increase in imports of capital goods and raw materials (to initiate local industries) contrary to expectations (Athukorala and Jayasuriya, 2000; Athukorala and Rajapatirana, 2000). The liberalization policies introduced in 1977 did not provide the desired outcome either due to not only inappropriate macroeconomic policies, but also other calamities such as the ethnic war and civil insurgencies a decade later. The early years of the liberalization process (from 1977-1988) were overtaken by political interests which at the time were on massive public sector investment on popular irrigation projects, housing schemes and transport. These projects, in particular the massive irrigation schemes, were under donor funded concessionary aids, in which accountability and efficiency of usage of funding were not a priority (Dunham and Kelegama, 1997). Therefore these investments resulted in widening budget deficits, inflationary pressures and hazardous economic effects similar to a “Dutch disease”. The economic disruptions and sharp increase in defense expenditures due to the ethnic war and civil insurgencies also led to deleterious effects on the country’s fiscal standing and overall macroeconomy, as well as the international competitiveness of the trading sector. After 1985 and due to foreign direct investment flows, the manufacturing sector exports, especially the garment industries, overtook exports from the traditional plantation crops, tea, rubber and coconut, inherited from British Colonial rule. However, Sri Lanka was not able to establish a high tech industrial sector through FDI due the increasingly competitive neighboring countries. Other rapidly growing countries in the East Asian region (NIC) such as Malaysia and Taiwan experienced rapid growth through these high tech industries. As highlighted by Dunham and Kelegama (1997), Sri Lanka inherited a highly politicized system and therefore the whole liberalization process was dominated by the establishment of inefficient institutions. Therefore, the effects of open economic policies were constrained by many factors such as, inappropriate political driven policies, war and lack of governance which led to loss of competitiveness in the international market.

The next step is to recover the private returns to physical capital and its externality effect. The estimates for physical capital, i.e. private returns to physical capital (α) and the externality effect of physical capital (λ) are functions of the estimated coefficients of war, openness and the parameter of the congestion effect (see (18)). As indicated in Section 2, by setting $\phi = 1$ an upper bound of the parameter for private returns to physical capital is found, $\alpha = \beta_2 + \beta_3 + \beta_4$. The upper bound is $\alpha \approx 1.20$ implying almost increasing returns to physical capital. This value is relatively high compared to the values reported for other developing countries (see for instance Tallman and Wang (1994) who found 0.66 for the Taiwanese economy). For developed countries the value has been found to be around 0.30. Studying the relationship between economic growth and FDI, Balamurali and Bogahawatte (2004) found almost constant returns to both FDI and domestic investment. Therefore, our estimate of increasing returns to capital would be a conservative figure.

The externality effect of physical capital, λ , can be calibrated using equation (19). We calibrated values for λ

for combinations of value within the ranges $\alpha = 0.33, 0.50, 0.65, 1.0$, and $\phi = 0.1, 0.3, 0.5, 0.6, 0.7, 0.8, 0.9, 1.20$. The results are presented in Table 5.

[Table 5 here]

When α is relatively low and the congestion parameter ϕ approaches 1 (consistent with an economy in equilibrium), the externality effect of physical capital would reach a high value (over 8.0). However, when values of α are relatively high, the values of λ (externality effects) tend to be lower. As observed by other studies, the returns to physical capital, α , tend to be higher for less developed countries. The estimates using Sri Lanka data indicate that α has been quite high during the sample period leading to very low externality effects of physical capital compared to its private returns at all levels of congestion (see Table 5). War is likely to have affected investment flows (see Grobar and Gnanaselvam (1993)) resulting in high returns to investment in physical capital; however, these high private returns did not translate into any sizable positive externalities for the Sri Lankan economy.

4 Discussion and Conclusions

We propose a theoretical and econometric framework to analyze the effect of war on economic growth of a developing country with an open economy by modifying the theoretical framework of Lau and Sin (1997a; 1997b). We test this framework by investigating the impact of war on the economic output of Sri Lanka during the period 1960-2008. We can draw several significant conclusions on Sri Lanka's economic performance from our findings. Benoit (1973)'s hypothesis of a positive effect of war on output does not hold for the case of Sri Lanka, a small economy with no arms-producing sector. The estimates are significant and the negative effects are estimated at an annual average of 9% of GDP. The effects are found to be significant both in the short as well as in the long run. Secondly, our study finds high returns to physical capital which suggests the country may have a relatively low level of capital accumulation and that would be imposing a constraint on production activities. As noted by Snodgrass (2004), physical capital accumulation could be affected during war time due to the destruction of infrastructure and productive capital, and the reduction in both private and foreign investment. Though we have not conducted an in depth analysis to check the effect of war on physical capital accumulation, Grobar and Gnanaselvam (1993) found significant effects of war on investment flows. Our results indicate that higher returns from investment in physical capital did not translate in any sizable positive externalities for the Sri Lankan economy. Finally, we do not find a statistically significant effect of openness on growth in the long-run; however, there are significant effects in the short-run. The inconsistent politically driven policies towards openness are the likely reason for these results. As highlighted by other studies, institutional reforms tend to lag behind liberalization attempts (Dunham and Kelegama, 1997). In the case of Sri Lanka the situation was exaggerated by war and civil unrest. Therefore, as the ethnic conflict has finally come to an end, a policy framework with appropriate institutional reforms is needed to lead the economy to rapid growth and development. Sharif (2011) has highlighted the importance of a proper institutional framework

without political influence to reduce ethnic discrimination, which is vital for future stability and development of the country. Overall, our findings contribute to the existing literature and provide an appropriate theoretically based modeling technique to analyze the relationship between war and economic growth.

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Table 1

The relationship between the Economic Model and the econometric estimation

Theoretical model	Econometric Approach
1) GROWTH MODEL	1) SPECIFICATION OF THE ECM
$y_t = Ak_t^{(\alpha+\lambda-(\lambda+\omega+\varphi)\phi}(1 + \gamma)_t^{t(1-\alpha-(1-\phi)(\lambda+\omega+\varphi))} w_t^\omega o_t^\varphi \varepsilon_t^P$	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	$\gamma = 0$
Speed of Adjustment of Output to Disequilibrium	Estimation of ECM and short run dynamics
2) PARAMETERS OF THE GROWTH MODEL	2) ESTIMATION OF COINTEGRATION VECTOR
	$\ln y_t = \beta_2 \ln k_t + \beta_3 \ln w_t + \beta_4 \ln o_t + \beta_5 t$
ω =externality effect of war	β_3
φ =externality effect of openness measure	β_4
γ = effect of technological change	$\beta_5/(1 - \beta_2 - \beta_3 - \beta_4)$, if $\phi = 1$
3) RECOVERING STRUCTURAL PARAMETERS	3) CALIBRATION
α = Private returns to physical capital	Upper bound $\alpha = \beta_2 + \beta_3 + \beta_4$, if $\phi = 1$
ϕ = Parameter of congestion effect	In the range of (0 - 1]
λ = externality effect of physical capital	$\lambda = (\beta_2 + (\beta_3 + \beta_4)\phi) - \alpha)/(1 - \phi)$

Table 2

War Effort Index - Estimates of equation (20)

Variable	Estimated coefficient (standard errors)
C	-0.27(0.17)
<i>miles</i>	0.15(0.07)**
<i>arm</i>	0.87(0.04)**
D77	0.27(0.06)**
R-squared	0.99
Adjusted R-squared	0.99
Akaike information criterion	-1.0
Schwarz criterion	-0.84
Hannan-Quinn criterion	-5.74
$\chi^2_{SC}(2)$ [p-value]	0.21 [0.90]
$\chi^2_{SC}(4)$ [p-value]	2.70 [0.60]
<i>Q-Stat</i> (1) [p-value]	0.1054 [0.75]
<i>Q-stat</i> (10) [p-value]	14.811 [0.14]
$\chi^2(Hetero)$ Breusch-Pagan-Godfrey [p-value]	5.93 [0.11]



Figure 1. Estimated War Effort Index

Table 3

Statistics for selecting the order of the ARDL

lag	AIC	BIC	$\chi^2_{(1)}$ [p-value]	$\chi^2_{(2)}$ [p-value]
1	-5.595773	-5.162760	0.073 [0.78]	4.10[0.53]
2	-5.566862	-4.970566	0.47 [0.49]	8.66[0.12]
3	-5.547787	-4.784974	5.13 [0.02]	15.19 [0.00]
4	-5.526970	-4.594326	15.16[0.00]	22.22[0.00]
5	-5.795368	-4.689498	7.37[0.00]	13.76[0.02]

Table 4

The Estimated Short Run Dynamics and Adjustment Coefficient of the ARDL (3,1,3,5)

Variable	estimated coefficient (standard errors)
$\Delta \ln y_{t-1}$	0.079(0.11)
$\Delta \ln y_{t-2}$	-0.02(0.11)
$\Delta \ln k_t$	0.24*(0.12)
$\Delta \ln \hat{w}_t$	-0.17**(0.05)
$\Delta \ln \hat{w}_{t-1}$	0.10*(0.05)
$\Delta \ln \hat{w}_{t-2}$	-0.08**(0.04)
$\Delta \ln o_t$	0.049**(0.02)
$\Delta \ln o_{t-1}$	-0.10**(0.02)
$\Delta \ln o_{t-2}$	-0.04**(0.02)
$\Delta \ln o_{t-3}$	-0.05**(0.02)
$\Delta \ln o_{t-4}$	-0.06**(0.02)
D01	-0.04*(0.02)
DO	0.02*(0.007)
D77	0.03**(0.007)
Constant	-0.90**(0.19)
ECT(-1)	-0.26**(0.05)
R-squared	0.80
Adjusted R-squared	0.69
Akaike information criterion	-5.99
Schwarz criterion	-5.34
Hannan-Quinn criterion	-5.74
LM- $\chi^2_{SC}(1)$ [p-value]	2.92 [0.09]
LM- $\chi^2_{SC}(5)$ [p-value]	6.23 [0.25]

Table 5

Recovered values for the externality effect of physical capital (λ) for different combinations of private returns to physical capital (α) and congestion effect (ϕ)

ϕ	$\alpha = 0.33$	$\alpha = 0.50$	$\alpha = 0.65$	$\alpha = 1.00$	$\alpha = 1.10$	$\alpha = 1.20$
0.1	1.03	0.85	0.68	0.29	0.18	0.07
0.3	1.30	1.06	0.85	0.35	0.20	0.06
0.5	1.79	1.45	1.15	0.45	0.25	0.05
0.6	2.22	1.79	1.42	0.54	0.29	0.04
0.7	2.92	2.36	1.86	0.69	0.36	0.02
0.8	4.34	3.49	2.74	0.99	0.49	-0.01
0.9	8.59	6.89	5.39	1.89	0.89	-0.11