Essays on the Relationship between Government Expenditure and Macroeconomic Performance

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Dedication

I dedicate this dissertation to my parents, Teruki and Kyoko Odawara.

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There are a great many people who have helped me complete this dissertation. My sincere appreciation goes to those individuals for their supports, encouragement, and contributions to this dissertation over the last few years.

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Abstract of Dissertation

Essays on the Relationship between Government Expenditure and Macroeconomic Performance

This dissertation studies the relationship between government expenditure and economic performance. The first essay investigates a nonlinear relationship between government spending and macroeconomic performance by estimating a threshold model that relates real GDP growth to three measures of government spending: government consumption, government investment, and total government expenditure as share to GDP. Using quarterly data for five OECD countries from 1970 through 2008, Hansen's (1996, 1999, and 2000) method is applied to test for the presence of threshold effects and to estimate the threshold values.

The main findings suggest that there is strong evidence of a nonlinear relationship between government spending and macroeconomic performance for all three measures of government spending in five OECD countries.

The results also indicate the importance of compositional effects when examining government spending. The impact on government investment on macroeconomic performance is quite different from that for government consumption.

Finally, there appears to be large country-specific variations in terms of the pattern of results.

The second essay investigates the impacts of fiscal policy on economic activity at both economic growth and business cycle frequencies for Latin American, East Asian, and European countries. Using a panel data set for 1970-2006 with annual frequency, I

estimate both short-and long-run effects of government spending on economic growth through a pooled mean group estimator, introduced by Pesaran, Shin, and Smith (1999).

The main results suggest that expansionary fiscal policy on infrastructure spending is favorable to real GDP per capita growth in the short-run. The long-run impacts of energy spending on real GDP per capita growth are also positive, while those of transport and communications spending are strongly negative. On the other hand, social spending appears to have a long-run positive relation with economic growth. However, the short-run relationship between education spending and real GDP per capita growth is negative. The short-run impacts of health spending are positive as long as an increase in the share of health spending is adjusted by a decrease in other spending shares. In addition, increasing government consumption expenditure is negatively correlated to economic growth both in the long-and short-runs.

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Chapter 1: Introduction

Government policy typically plays an essential role in the macroeconomic performance of countries. Apart from defining the legal and regulatory structure for economic activity, governments pursue a number of spending initiatives designed to promote output growth and employment. At the same time, government expenditures may interfere with the efficient workings of the economy and thus have a negative impact on economic performance. Thus, both the theoretical predictions and empirical findings on the macroeconomic effects of changes in government expenditure are mixed. It is of interest therefore to identify not only the overall impact of government spending on economic performance but also the impact of different types of spending. In addition, the size of government expenditures relative to the economy may affect the influence those expenditures exert. Expenditures that are effective or ineffective on a very small scale could see that effectiveness or ineffectiveness reversed as they grow relative to the economy. This means it is important to investigate the relationship between the size of government expenditure and macroeconomic performance. Finally, in order to find a "turning point" in the relationship, where the optimal size for government spending may exist and achieve the effective allocation of government expenditure, it is essential to understand which components of government expenditure are most favorable to economic growth, and redirect the limited resources towards more productive and efficient sectors.

In this dissertation, two key questions relating to the relationship between government expenditure and economic performance are investigated: what is the growth enhancing level of overall government expenditure and which components of government

spending have positive or negative impacts on macroeconomic performance in the short- and long-runs?

Chapter 2 presents the first essay, which explores the possibility of a nonlinear relationship between the level of government spending and macroeconomic performance by using the quarterly data for five OECD countries from 1970 through 2006.

The first essay contributes to the existing literature on the relationship between government spending and economic growth by identifying a turning point in the relationship between three measures of government spending and real GDP growth rates. A number of studies claim that increasing government spending has an important role in promoting economic activity, but over-expanding government size can adversely affect the economy, suggesting that there may be a nonlinear relationship between the level of government spending and economic performance.

The threshold model was employed adopting Hansen's (1996, 1999, and 2000) method to test whether the threshold effects exist and to estimate the threshold government size.

The main results from the analysis confirm that a nonlinear relationship with economic performance exists for three different measures of government spending in the five countries. In addition, the pattern of results supports the concept that there may be an optimal size for government spending.

Third, compositional effects appear to be important when examining government spending. That is, the impact on government investment on real GDP growth has a quite different pattern from that for government consumption. Government investment has a

positive impact on real GDP growth below the threshold value but the impact becomes ambiguous above the threshold. In contrast, it is much less obvious that government consumption has a positive role in increasing real GDP growth except for Japan.

Finally, the results indicate large country-specific variations in terms of the pattern of results, which would probably depend upon each country's fiscal experience. Moreover, countries with relatively high average government spending ratios tend to have higher threshold values because the beneficial aspects of government spending are more extensive.

Chapter 3 contains the second essay which examines the impacts of fiscal policy on economic activity at both economic growth and business cycle frequencies for Latin American, East Asian, and European countries. Using a panel data set for the period 1970-2006, the essay presents the results of estimating both short-and long-run effects of government spending on growth through the pooled mean group (PMG) estimator, introduced by Pesaran, Shin and Smith (1999). The essay also looks at the separate effects of infrastructure and social spending.

The main contribution of this essay is the identification of the impacts of various components of government spending on economic growth. It also attempts to addresses both the short-and long-run effects of these components simultaneously. There is a general perception that excessive government spending is harmful on long-run economic performance, while at the same time, it is generally accepted that expansionary government spending is favorable at business cycle frequencies. This is a useful contribution because given limited government resources, it is critical to understand which components of

government spending promote growth at different time horizons and adjust resources towards more productive and efficient areas.

The essay presents a pooled autoregressive distributed lag (ARDL) error-correction model thorough the PMG estimator, which allows the country specific heterogeneity in the short-run but constraints the long-run coefficient to be same across countries. This methodology is in particular useful to address the diversity of fiscal policy approaches that vary across countries.

The results suggest that government spending which is considered productive such as infrastructure and social spending has a long-run positive relationship with growth, while spending which is considered unproductive such as consumption expenditures appears to be strongly negatively correlated to growth in both the short-and long-runs. The exception is transport and communications spending whose long-run effect on growth is found to be strongly negative. This result is in contrast to a number of studies that found positive impacts of infrastructure spending, in particular transport and communications spending. The negative long-run effect of transport and communications spending might suggest that productive expenditure could turn unproductive if it is used excessively or inefficiently. Or the existing level of government spending is above the optimal level so that additional government spending adversely affects the economy.

The results also show that expansionary fiscal policy on government spending on infrastructure and health is growth enhancing at business cycle frequencies. The short-run impacts of education spending are negative, which might indicate that the positive returns of education spending to growth become measurable, not in the short-run, but

only in the long-run. This is consistent with the idea that education is a long-term investment.

Chapter 4 summarizes the major findings of these two essays and policy implications drawn from them. The conclusions drawn from these studies will have valuable implications to policy makers when deciding what level of government spending to be most growth enhancing and which components of government expenditure to adjust in order to attain higher economic growth under limited government resources.

Chapter 2: A Threshold Approach to Measuring the Impact of Government Size on Economic Growth

2.1 Introduction

The impact of government spending on an economy's macroeconomic performance has long been an important issue when considering the efficacy of fiscal policy, but measurement of its impact has taken on additional importance with the consideration of alternative fiscal policy responses to the recent economic recession. To date, both the theoretical predictions and empirical results on the macroeconomic effects of changes in government expenditure are mixed.

Ram (1986), Kormendi (1983) and Kormendi and Meguire (1986) find that expanding government size will promote economic growth. They argue that increasing government expenditure will improve the country's investment environment, and eventually cause a "crowding-in" effect on private investment. On the other hand others[1] find a negative relationship between government spending and growth. They make arguments that high levels of government spending will have negative consequences because they distort the economy due to crowding out, generate inefficient allocation of government resources, and ultimately lead to higher future tax burdens.

This apparent inconsistency is sometimes explained by arguing that the impact of additional government expenditure on the economy differs depending on the existing level of government expenditure, suggesting there might be a nonlinear relationship

[1] Bradley and Peden (1989), Engen and Skinner (1991), Landau (1983), and Mitra (2006).

between the level of government spending and macroeconomic performance.[2] The key idea is that government has an important role in promoting economic performance by protecting private property, building shared infrastructure and providing public goods. However, over-expanding the government size causes distortions and misallocations which can adversely affect the economy. In addition, a number of empirical studies have suggested that the impact of government expenditure on output depends on the composition of that expenditure.

This paper contributes to the existing literature on the relationship between government spending and macroeconomic performance by estimating a threshold model that relates real GDP growth to three measures of government spending for five different OECD economies. The model was originally proposed by Chen and Lee (2005) in investigating the role of government spending in Taiwan. Chen and Lee estimated a threshold model version of Ram's (1986) two-sector model, and this approach is adopted for several reasons. First, a threshold model is a very useful framework for analyzing a possible nonlinear relationship when there is little theoretical specification of that relationship. That is the case here. While there is a broad discussion of the concept that the beneficial effects of government spending could dissipate or even turn negative with increasing levels of that spending, there is no theoretical basis for an explicit functional form. Moreover the threshold model tests for the presences of nonlinearity and defaults to a linear model if the data support such a specification.

[2] See, for example, Vedder and Gallaway (1998) or Sheehey (1993).

Second, by separately examining the effects of government consumption and government investment, this approach allows for investigating compositional effects. It is generally agreed that appropriate government investment, at least up to some level, can have beneficial effects on macroeconomic performance but there is much more skepticism about government consumption. Allowing each to be a threshold variable in separate equations allows for estimating different relationships between GDP growth and government investment and GDP growth and government consumption. Also, to test whether there is an overall "scale of government effect" a measure of total government expenditure can be used as a threshold variable.

Finally, the threshold model is applied to countries that have had very different levels of government spending (compared to the size of the respective economy) and very different patterns of change in the level of government spending. This approach can therefore provide insight into how those different experiences influence the relationship between government spending and macroeconomic performance.

In addition to detailed results for each country, the analysis produces four main results. First, there is strong evidence of a nonlinear relationship between government spending and macroeconomic performance. The statistical tests for the existence of a threshold effect cover three different measures of government spending across five different OECD countries for a total of fifteen tests. In all cases, the results indicate rejection of the null hypothesis of no threshold effect. This result holds both across government spending measures and countries.

Second, the pattern of results generally supports the concept that there may be an

optimal size for government spending. In most, but not all, instances the effects of government spending on real GDP growth are found to be less positive or even negative for values of government spending above the threshold. Such a result suggests a situation in which government spending may have beneficial impacts on the economy up to a point, beyond which those positive impacts dissipate or turn negative.

Third, compositional effects can be important when examining government spending. The results indicate that the impact on government investment on macroeconomic performance is different from that for government consumption. In four of the five countries studied, government investment was found to have a positive impact on real GDP growth below the threshold value but a zero impact above the threshold. In contrast, there is little evidence that government consumption has a positive impact on macroeconomic performance with only Japan showing a positive impact and all other counties showing either no impact or a negative impact on real GDP growth.

Fourth, the results suggest that country-specific conditions and institutions are important. The pattern of results is not universal across all countries and appears to depend upon each country's fiscal experience. For example, Japan exhibited a very different pattern of results for the impact of government investment on real GDP growth but Japan experienced a very different pattern of government investment than the other four countries in terms of both a very high level and a persistent decline. In addition, countries with relatively high average ratios of government spending also have higher threshold values. This suggests that countries in which the beneficial aspects of government spending are more extensive end up with higher levels of spending.

The structure of the rest of this paper is as follows. Section 2 provides a review of relevant literature. Section 3 introduces the theoretical model developed by Ram (1986) and applied in the empirical analysis. Section 4 presents the econometric methodology and Section 5 discusses the data. The empirical results are presented and discussed in Section 6. Section 7 is the conclusion.

2.2. Literature Review

A strand of literature that investigates the relationship between the size of government and economic growth often reached inconclusive results. Some argue that a larger government size is harmful for economic growth as overgrown government expenditure is often used inefficiently, crowds out private investment, and results in higher interest payments and tax burdens. Estimating a quadratic function model, Vedder and Gallaway (1998) find that government size and growth are negatively correlated in the U.S. Using the post-war annual U.S. data (1948-1986), Bradley and Peden (1989) also find the negative relationship between government size and productivity, as well as output growth. Romer and Romer (2010) show that tax changes to finance increased government spending have a sizable negative impact on growth using the post-war U.S. data.

Yet others claim that the government plays a critical role in the process of economic development and tends to influence the economy positively. Ram (1986)[3], Kormendi (1983), and Kormendi and Meguire (1986) find the impact of government size

[3] Ram (1986) used the sample of 115 countries for the period 1960-1980 and defined government size as government consumption expenditure.

on growth is positive as government expenditure can improve the private investment environment, which will lead to higher economic growth.

Thus, evidence for the effect of government expenditure on economic activity is contradicting. Vedder and Gallaway (1998) and Sheehey (1993) explain that this inconsistency is caused by a non-linear relationship between government size and economic growth. That is, the impact of government expenditure differs depending on the optimal size of government expenditure, and there exists a threshold value where the marginal benefit of increasing government size no longer exceeds the cost of overgrown government expenditure.

Previous studies obtained the optimal government size for various countries. Vedder and Gallaway (1998) find the optimal total government expenditure size of the U.S. as 17.5 percent of real GDP during 1947-1997[4]. They also infer the optimal government size of other OECD countries: 21.4 percent in Canada (1854-1988), and 21.0 percent in the United Kingdom (1830-1988). Chen and Lee (2005), on the other hand, use the Hansen's threshold regression model using the quarterly data of Taiwan from 1979 Q1 to 2003 Q3 and confirm that all three classifications of government expenditure as a ratio to GDP: total government expenditure, government investment spending, and government consumption expenditure, have threshold effects. The optimal government size found for these expenditures is 22.8, 7.3, and 15.0 percent, respectively.

Moreover, a number of studies claim that the relationship between the government size and growth depends on the components of government expenditures. Afonso and

[4] The data used is federal government spending.

Furceri (2008) analyze the impact of government size using various components of government expenditures in OECD and EU countries[5]. Their findings suggest that total expenditure has a negative impact on the real per capita GDP for both the OECD and EU countries. The components of total spending appear to have diminishing effects for both countries. Both subsidies and government consumption have a significantly negative impact on growth, government investment does not significantly affect growth, and only transfers have a positive and significant effect only for the EU countries.

Another hypothesis is that the effect of fiscal adjustment on output differs depending on whether the types of spending to be adjusted are politically sensitive or politically less sensitive. Cuts to politically sensitive items such as government transfers and consumption expenditure will have relatively larger effects on growth, while cuts to politically less sensitive item such as government investment will have smaller effects. The key idea is that the former signals a stronger and credible commitment to structural adjustment, while the latter shows weaker confidence in the government (Leigh, et al. 2010).

On the other hand, Lin (1994) argues that the contribution of government investment to the economy will be higher than that of government consumption expenditure because the former tends to encourage private investment. In contrast, many studies claim that the crowding out effect of government investment in particular in developing countries. Mitra (2006) finds the presence of crowding out in the short-run using data for India.

[5] The breakdown of government expenditures they used include: total expenditure and its breakdown in transfers, subsidies, government investment, and government consumption (wage and non-wage component, separately).

Empirical literature analyzing the panel data indicates that the difference in the level of development appears to be one of the major factors to determine the impact of government size on growth. Folster and Henrekson (2001) and Sheehey (1993) confirm a robust negative relationship between high public expenditure and growth for high income countries[6]. Dar and AmirKhalkhali (2002) find that the larger size of government impacts inversely on long-term growth, and both total factor productivity growth and the productivity of capital are weaker in OECD countries where government size is larger.

2.3 Theoretical Model

In this paper, Ram (1986)'s two sector production theoretical model as extended by Chen and Lee (2005) is the basis for the empirical work. In this section, the model is presented and explained, and the equation to be estimated is derived.

The economy consists of two sectors: the government sector (G) and non-government sector (C). Output in each sector depends on labor and capital inputs. The output in the government sector (government size) has an externality effect on output in the non-government sector.

(1) $C = C(L_C, K_C, G)$

(2) $G = G(L_G, K_G)$

(3a) $Y = C + G$

[6] Public expenditure is defined as total government expenditure as share of GDP and the share of government consumption expenditure in real GDP, respectively. Sheehey (1993) finds that the optimal government size (the share of government consumption expenditure in real GDP) as 15%.

(3b) $L_C + L_G = L$

(3c) $K_C + K_G = K$

(4) $\frac{G_L}{C_L} = \frac{G_K}{C_K} = 1 + \delta$

Eqs. (1) and (2) are the production function of non-government and government sectors, respectively. The subscripts indicate sectoral inputs. Eq. (3a) indicates that the total output is the sum of C and G. Eqs. (3b) and (3c) are the total inputs of labor and capital where the total labor (or capital) stock is the sum of labor (capital) input in the non-government and government sectors. Eq. (4) is the relative factor productivity in the two sectors where δ indicates the difference of marginal productivity between the factor inputs in the two sectors. That is, $\delta > 0$ implies the marginal productivity of the government sector is higher than that of the non-government sector, and $\delta < 0$ indicates the opposite.

Totally differentiating Eqs. (1) and (2),

(1') $dC = \frac{\partial C}{\partial L_C} dL_C + \frac{\partial C}{\partial K_C} dK_C + \frac{\partial C}{\partial G} dG$

$dC = C_L dL_C + C_K dK_C + C_G dG$

(2') $dG = \frac{\partial G}{\partial L_G} dL_G + \frac{\partial G}{\partial K_G} dK_G$

$dG = G_L dL_G + G_K dK_G$

Transforming (3a), (3b), and (3c) into total differentials,

(3a') $dY = dC + dG$

(3b') $dL_C + dL_G = dL$

(3c') $dK_C + dK_G = dK$

Substituting Eqs. (4), (1'), and (2') into (3a'),

$$dY = C_L dL_C + C_K dK_C + C_G dG + (1+\delta)C_L dL_G + (1+\delta)C_K dK_G$$

$$= C_L(dL_c + dL_G) + C_K(dK_C + dK_G) + C_G dG + \delta(C_L dL_G + C_K dK_G)$$

From Eqs. (3b'), (3c'), and (4),

(5) $$dY = C_L dL + C_K dK + C_G dG + \frac{\delta}{1+\delta} dG$$

Dividing Eq.(5) by Y and multiplying $\frac{G}{G}$ with the last term,

(6) $$\frac{dY}{Y} = C_L \frac{dL}{Y} + C_K \frac{dK}{Y} + \left(C_G + \frac{\delta}{1+\delta}\right)\frac{dG}{G}\frac{G}{Y}$$

Setting $\alpha \equiv C_K$ and $\beta \equiv C_L\left(\frac{L}{Y}\right)$,

$$(7) \qquad \dot{Y} = \alpha \frac{I}{Y} + \beta \dot{L} + \left(C_G + \frac{\delta}{1+\delta}\right)\dot{G}\frac{G}{Y}$$

where α and β indicate the marginal production of the capital and the production elasticity of the labor in the non-government sector, respectively. C_G is the marginal externality effect from the production of the government sector imposed on the production of the non-government sector.

From Eq. (7), the empirical equation to be estimated is the following:

$$(8) \ \dot{Y}_t = \delta_0 + \delta_1\left(\frac{I_t}{Y_t}\right) + \delta_2 \dot{L}_t + \delta_3 \dot{G}_t\left(\frac{G_t}{Y_t}\right) + e_t$$

where $\dot{Y}_t$: real GDP growth rates at time t, $\frac{I_t}{Y_t}$: private gross fixed capital formation (GFCF) as a share of GDP at time t, $\dot{L}_t$: labor force growth rates at time t, $\dot{G}_t$: growth rates of government expenditure at time t, and G/Y_t: government expenditure as a share of GDP at time t, and e_t: the error term which is assumed to be independent and identically distributed (iid) with mean zero and variance σ^2. The sign of δ_3 indicates the multiple effects, that is, the government sector affects economic growth through the

following two channels: a direct channel through the government sector (factor productivity differential) and an indirect channel of government sector through the non-government sector (externality effect).

2.4 Econometric Methodology

The theoretical model derived above provides a structure for estimating the impact of government spending on real GDP growth. However, as specified it does not allow for that relationship to change with changes in the level of spending. To do so requires a nonlinear model. One approach would be to estimate a nonlinear functional form. For example, Vedder and Gallaway (2008) use a quadratic functional form applied to the U.S. data and do find a nonlinear relationship between government spending and economic growth. However a difficulty with this approach is that it requires knowledge of the shape of the nonlinearity prior to estimation. An alternative approach is to use a threshold model to test for any nonlinearity[7]. This approach allows the data to determine if a nonlinearity exists and to estimate the size of any differences in effect[8]. There are several reasons for the use of the Hansen threshold model is considered most appropriate among other alternatives to examine a nonlinear relationship between the measures of government spending and real GDP growth. First, the threshold model allows analyzing a possible

[7] In addition to the threshold model, I estimated a quadratic model for the U.S. The complete results are presented in Appendix 2.1 and they generally confirm the results of the estimated threshold model. The linear terms for all three government spending variables were positive and the squared terms were negative. They were not statistically significant, however, in two of the three cases.

[8] The presence of one or more unknown structural break(s) was tested using Quandt-Andrew break point test with 15 percent trimming (using EViews) for the United States. The results indicated that 1981 Q1 and 2003 Q1 (2002 Q2 for government investment and total government expenditure) were the most likely breakpoints. All three measures of the summary statistics failed to reject the null hypothesis of no structural break for 1981 Q1, while all three measures of summary statistics rejected the null for 2003 Q1 (two out of three measures rejected the null for 2002 Q2 for government investment and total government expenditure).

nonlinear relationship without requiring specific functional form assumptions. This is a useful feature as there is no theoretical basis for an explicit functional form on the relationship between government spending and real economic activity. The results estimating a quadratic model also confirm that the appropriate functional form differs depending on the measure of government spending used and therefore is unknown prior to estimation.

Second, it is more likely that fiscal policy in the form of government spending influences the country's economic performance through various channels including the real sector productivity and private sector performance. Although only the parameter of government spending variable changes in the quadratic model, the threshold model allows all the parameters of the variables included in the model to change depending on whether the ratio of government spending to GDP is below or above the threshold value.

Following Chen and Lee (2005), I employ Hansen's (1996, 1999, and 2000) method to test whether the threshold effects exist and to estimate the threshold government size. In order to estimate a threshold model, Eq. (8), which is a linear economic growth model, is transformed into the two regime of Threshold Autoregressive (TAR) model:

$$\dot{Y}_t = \beta_1 X_t + \varepsilon_{1t} \text{ if } G/Y_t \le \theta \tag{9}$$

$$\dot{Y}_t = \beta_2 X_t + \varepsilon_{2t} \text{ if } G/Y_t > \theta \tag{10}$$

where the term G/Y (government size represented by government expenditure as a share

of GDP) is the threshold variable, which is included as an independent variable, and splits the sample into two groups, $\dot{Y}_t$ is the dependent variable, X_t is a set of independent variables, ε_{it} is the error term which is assumed to be iid with mean zero and variance σ^2, and θ is the threshold value.

Eqs. (9) and (10) are called a sample-split or threshold regression model. The specification allows the regression parameters to differ depending on the value of the threshold variable G/Y. Eqs. (9) and (10) can be written in a single equation, assuming that the dummy variable is $d_t(\theta) = \{G/Y_t \le \theta\}$ where $\{\cdot\}$ is the indicator function, and setting $X_t(\theta) = X_t d_t(\theta)$:

$$\dot{Y}_t = \beta' X_t + \rho' X_t(\theta) + \varepsilon_t \text{ and } \varepsilon_t \sim iid(o, \sigma_t^2) \tag{11}$$

where $\beta = \beta_2$, $\rho = \beta_1 - \beta_2$, and the error term $\varepsilon = [\varepsilon_{1t} \varepsilon_{2t}]'$.

Transforming Eq. (11) into a two regime TAR model can be expressed as:

$$\begin{aligned} \dot{Y}_t = &\left(\delta_{10} + \delta_{11}\left(\frac{I_t}{Y_t}\right) + \delta_{12}\dot{L}_t + \delta_{13}\dot{G}_t\left(\frac{G_t}{Y_t}\right)\right) d\left[\frac{G_t}{Y_t} \le \theta\right] \\ &+ \left(\delta_{20} + \delta_{21}\left(\frac{I_t}{Y_t}\right) + \delta_{22}\dot{L}_t + \delta_{23}\dot{G}_t\left(\frac{G_t}{Y_t}\right)\right) d\left[\frac{G_t}{Y_t} > \theta\right] + e_t^* \end{aligned} \tag{12}$$

The threshold value θ is identified by estimating Eq. (12) through finding the

minimum sum of squared errors. It is important to make sure that a minimal set of observations are included in both below and above the threshold. Thereby, as suggested by Andrew (1993), the threshold variable is set to be found between 15 and 85 percentile of its value[9]. A grid search method is adopted to find the threshold value which minimizes residual sum of squares[10].

The sum of squared errors is expressed as:

$$(13) \qquad S_1(\theta) = \hat{e}_t(\theta)'\hat{e}_t(\theta)$$

The optimal threshold value is the least squares estimators of θ, which is shown as:

$$(14) \qquad \hat{\theta} = \arg\min S_1(\theta)$$

The residual variance is:

$$(15) \qquad \hat{\sigma}^2 = \frac{1}{T}\hat{e}_t'\hat{e}_t = \frac{1}{T}S_1(\hat{\theta})$$

[9] Appendix 2.2 contains the explanation on how to calculating the percentiles of the threshold value.

[10] The details on the grid search algorithm are explained in Appendix 2.3.

2.4.1 Testing for a Threshold

Once the threshold value θ is determined by the grid search method and estimating Eq. (12), the null hypothesis of no threshold effect is tested using the maximum likelihood ratio test. The hypothesis of no threshold effect by testing Eq. (12) is shown as:

(16) $H_0 : \delta_{1i} = \delta_{2i}; \; i = 0,1,2,3.$

Since the threshold value is $\theta = \theta_0$ (θ is the true value of θ_0) under the null hypothesis and the threshold parameters θ are not identified under the null hypothesis of no threshold effect, traditional test statistics have non-standard distributions, and thereby cannot be used. The p-values are computed through a bootstrap sampling in order to simulate the asymptotic distribution of the likelihood ratio test[11]. The bootstrap sampling produces asymptotically correct p-values. The maximum likelihood estimator is applied to test whether the threshold value achieves the asymptotic distribution of the statistic.

The likelihood ratio test of the null is based on:

(17) $F_1 = \dfrac{S_0 - S_1(\hat{\theta})}{\hat{\sigma}^2}$

[11] For the details on the bootstrap procedure, please see Appendix 2.4. Stata software is used for analysis.

where S_0 and $S_1(\hat{\theta})$ are the sum of squared errors under the null hypothesis of no threshold effect and its alternate, respectively from the estimated threshold model. As explained earlier, the asymptotic distribution of F_1 is non-standard due to the presence of nuisance parameters which are not identified under the null hypothesis[12].

Hansen (1996, 1999, and 2000) indicates that when the threshold effects exist, the threshold estimator $\hat{\theta}$ has a consistency with an actual threshold value θ_0. Hansen uses the maximum likelihood estimator to test the threshold value θ to achieve the asymptotic distribution of the statistic. The null hypothesis of the threshold value is $H_0 : \theta = \theta_0$ (θ is the true value of θ_0) and the likelihood ratio statistics are:

$$(18) \qquad LR(\theta_0) = \frac{S_1(\theta_0) - S_1(\hat{\theta})}{\hat{\sigma}^2}$$

where $S_1(\theta)$ and $S_1(\hat{\theta})$ are the sum of squared errors from (13) given the true and estimated value, respectively. Once the asymptotic distribution of $LR(\theta_0)$ is obtained, this is used to form the valid asymptotic confidence intervals for the estimated threshold values[13].

[12] The asymptotic distribution of F_1 is non-standard, and strictly dominates the χ^2 distribution (Hansen 1999).

[13] The statistics of $LR(\theta_0)$ are not normally distributed and Hansen (2000) computes their no-rejection region $c(\alpha)$. If $LR(\theta_0) \le c(\alpha)$, where $c(\alpha) = -2\ln\left(1-\sqrt{1-\alpha}\right)$, then the null hypothesis cannot be rejected (Chen and Lee, 2005).

2.4.2 Multiple Threshold Effects

Once the estimation results suggest that at least one threshold exists by rejecting the null hypothesis, it should be examined whether there is more than one threshold. The existence of multiple thresholds can be tested by repeating the same procedure for the null hypothesis that only one threshold exists against its alternative that two thresholds exist.

In order to check for the existence of multiple thresholds, I search for the second threshold value θ_2, where the threshold is monotonically increasing as $\theta_1 < \theta_2$ [14]. Once again I apply the grid search method. Fixing the first threshold estimate $\hat{\theta}_1$, the second threshold estimate condition is given:

$$(19) \quad S_2^r(\theta_2) = S(\hat{\theta}_1, \theta_2) \text{ if } \hat{\theta}_1 < \theta_2$$

$$S(\theta_2, \hat{\theta}_1) \text{ if } \theta_2 < \hat{\theta}_1$$

where $S_2^r(\theta_2)$ is the minimizing sum of squared errors form the second-stage threshold estimate.

The second threshold estimator is shown as:

[14] The main interest of this paper is to identify the major turning point in the government spending and real GDP relationship, which is captured by the first threshold. Once the first threshold is identified, finding the second threshold which is less than the first threshold would be redundant. Thereby, the second threshold is ordered as monotonically increasing.

(20) $\hat{\theta}_2^r = \arg\min S_2^r(\theta_2)$

The likelihood ratio test statistic is expressed:

(21) $F_2 = \dfrac{S_1(\hat{\theta}_1) - S_2^r(\hat{\theta}_2^r)}{\hat{\sigma}_2^2}$

where $S_1(\hat{\theta}_1)$ is the sum of squared errors in single threshold regime, and the variance of the error terms is:

(21) $\hat{\sigma}_2^2 = \dfrac{1}{T} S_2^r(\hat{\theta}_2^r)$

If the test statistic for the two thresholds test F_2 is smaller than the critical value, it indicates that the null hypothesis of one threshold is not rejected, and there exists only one threshold. The number of thresholds is determined by repeating the same procedure until the null hypothesis cannot be rejected. Once the number of thresholds is determined, the sample data is divided into the number of threshold regimes. In this paper, the maximum number of thresholds is restricted to two even though more than two thresholds exist. Because the number of observations is relatively small (152 observations for each country), allowing more than two thresholds could end up leaving too few observations for each regime.

2.5 Data Description

In this paper, quarterly data from 1970 Q1-2008 Q4 for the U.S., Australia, Canada, Japan, and the UK are used. In order to adjust for seasonality of the data, I use annual quarterly growth rates year-over-year by comparing the data of this quarter with the same quarter in the previous year. The source for fiscal data, GDP, private gross fixed capital formation (investment), and labor force data is the OECD Economic Outlook database. The three measures of government spending series examined are: consumption expenditure[15], gross investment[16], and total expenditure[17].

Table 2.1 presents descriptive statistics of main variables by country. In the U.S., both the government consumption and investment reached their maximum values of 23.4 and 3.8 percent, respectively in the first quarter of 1970, while total government expenditure reached its maximum value of 40.7 percent in the fourth quarter of 2008. In a cross-country comparison, the UK had the highest government consumption of 28.3 percent among the five OECD countries in the fourth quarter of 1975. Japan marked the highest value of government investment of 10.4 percent in the first quarter of 1973. The highest value of total government expenditure of 53.5 percent was attained in the second quarter of 1992 in Canada.

Identifying countries with relatively high ratio of government spending to those with relatively low ratio, the average size of government consumption varies from a

[15] Government consumption expenditures are services (such as education and national defense) produced by government that are valued at their cost of production. They exclude government sales to other sectors and government own-account investment (construction and software).

[16] Gross government investment consists of general government and government enterprise expenditures for fixed assets; inventory investment is included in government consumption expenditures.

[17] Total expenditure consists of current expenditure, gross government investment, capital transfer payment, and net purchases of non-produced assets.

relatively low 15-18 percent for Japan, the U.S. and Australia, to a high in the 22-23 percent range for Canada and the UK. The average size of government investment ranges from the relatively low 1.7-3.2 percent for Australia, Canada, the UK, and the U.S., to the high of 7.4 percent for Japan. As for the average size of total government expenditure, it covers from the lower range of 33-35 percent for Australia, Japan and the U.S., to the higher range of 43-44 percent for Canada and the UK.

The changes of average government size by decade and country are shown in Table 2.2. In the U.S., government consumption clearly shows a declining trend from the mean value of 20.6 percent in the 1970s to 14.7 percent for 2000-08. In contrast, government investment and total expenditure have remained relatively unchanged since the 1980s. In both Canada and the UK, government consumption has been falling, while it has been rising in Japan. In Australia, it has kept the range of 17-18 percent for the past four decades. As for government investment, there is a clear declining trend in Japan and the UK after the 1970s, while in other countries it has remained at the similar level over time. It is also worth mentioning that average government investment in Japan (7.4 percent) is much higher compared to that of other countries (1.7-3.2 percent).

Lastly, total government expenditure has been rising through 1990s and falling in the most recent period in Australia and Canada. In the UK, it fell by roughly 3 percent in the last two decades. In contrast, Japan's total government expenditure has been steadily rising. Table 2.3 shows the correlations of main variables and Table 2.4 explains the definition of variables, respectively. Figures 2.1.1 through 2.1.5 depict the time path of main variables by country.

2.6 Estimation Results

This first empirical issue to be resolved is the existence of threshold effects. Because threshold models are nonlinear, traditional test statistics are not applicable and an alternative approach must be followed. Hansen (1996, 1999, and 2000) used a bootstrap approach to find the requisite p-values[18]. For each country a sequence of threshold tests is pursued which are general enough to allow for zero up through two thresholds.

Tables 2.5.1 through 2.5.5 report test statistics with their bootstrap p-values, confidence interval, and threshold values by the measures of government expenditures and country. The results are summarized below, which shows the number of thresholds identified for each country:

Number of Thresholds Identified by Country and Government Spending Variable

	US	Australia	Canada	Japan	UK
Government Consumption	1	1	1	2	1
Government Investment	2	2	2	1	1
Total Government Expenditure	2	1	2	2	1

The results represent strong evidence of a nonlinear relationship between government spending and real GDP growth as in each instance the null hypothesis of no threshold is rejected. An examination of the estimated thresholds produces some interesting similarities as well as differences. First, the levels of the estimated thresholds are consistent, by government spending variable across countries. The threshold values for

[18] 1000 bootstrap replications were used for all the bootstrap tests.

government consumption are in the low double-digit range for all countries whereas the threshold values for government investment are in the single digit range for all countries. Also, in those instances in which two thresholds are identified, the second threshold variable is quite close to the first threshold variable, suggesting that the actual "turning point" in the government spending and real GDP relationship is in that area.

Thresholds Identified by Country and Government Spending Variable

	US	Australia	Canada	Japan	UK
Government Consumption	19.6%	19.0%	24.2%	14.7% 15.2%	26.8%
Government Investment	3.0% 3.1%	2.3% 2.6%	2.3% 2.6%	8.5%	1.4%
Total Government Expenditure	35.6% 36.0%	37.6%	46.1% 48.3%	34.3% 37.0%	45.4%

Nevertheless, there are important differences across countries. The threshold for government consumption ranges from 15 percent in Japan to nearly 27 percent for the UK. In contrast, the thresholds for government investment range from a low of 1.4 percent for the UK to a high of 8.5 percent for Japan.

Thus the results have indicated that important threshold effects exist and that the threshold points vary for government consumption and government investment. Another important aspect of the results is the nature of the change that takes place at the threshold.

Recall the threshold model implies that the parameters of the model are different on one side of the threshold than they are on the other.

In addition, the coefficient on the government spending term includes the indirect effect of additional government spending on the private sector. Thereby, this serves as a measure of "crowding out". The estimated coefficient on government spending in the threshold model already includes the crowding out effect, and it occurs whenever the coefficient on the government spending variable turns to zero or negative.

Tables 2.6.1 through 2.6.5 display the regression estimates of the linear as well as threshold models by threshold variable and country.

The detailed results on a country-by-country basis will follow but a number of important overall results emerge. First, government investment tends to have a significant impact on real GDP growth below its threshold but that effect dissipates when the ratio of government investment to GDP gets above the threshold. As the following table shows, this pattern holds for four out of the five countries. Note that a "zero" entry in the table reflects the fact that the estimated coefficient was not significantly different from zero. This means that initial government investment contributes to macroeconomic performance but the effect dissipates at the amount of government investment increases. The exception is Japan which shows just the opposite pattern. Interestingly Japan is very different from the other four countries in its experience with government investment. Its average ratio of government investment is at least three times as large as the other countries' ratios and it is the only country to experience a persistent decline in the government investment ratio.

Estimated Coefficients on the Government Spending Variable

Government Investment

Country	Below Threshold	Above Threshold
United States	5.44	0
Australia	2.53	0
Canada	3.65	0
Japan	0	1.12
United Kingdom	3.49	0

The results provide much less support for a positive role for government consumption in increasing real GDP growth. As the following table shows, only Japan experienced a positive effect of government consumption on real GDP growth and that effect diminished sharply when the level of government consumption got above the threshold. In the only other instance of a significant government consumption effect, the U.S. experienced a negative effect above the threshold.

Estimated Coefficients on the Government Spending Variable

Government Consumption

Country	Below Threshold	Above Threshold
United States	0	-8.32
Australia	0	0
Canada	0	0
Japan	6.77	0.92
United Kingdom	0	0

When taken together, the results for government investment and government consumption are generally consistent with the concept that there may be an optimal size for government spending. In its pure form, this concept requires the impact of government spending on macroeconomic performance to be first increasing and then decreasing. If the level of spending is below the optimum value, then macroeconomic performance can be improved by increasing the level of spending. If the level of spending is above the optimum value, then macroeconomic performance can be improved by reducing the level of spending. While the previous results do not exactly match this classic pattern, they are consistent with it.

There are a series of possible reasons why the impact of government spending could be different above the threshold. First, the "turning point" in the government spending and real GDP relationship captures diminishing marginal product of government spending. In other words, initial government spending is promoting economic activity but the effect falls as the level of government spending rises. Second, governments tend to undertake their best projects first, so as spending levels climb, less effective projects are funded. Third, as described earlier, "crowding out" starts to dominate as the level of spending rises. Lastly and related to the second reason, at high levels of spending less scrutiny is given to each project so more inefficient projects are funded. For example, in the time of recession the governments which have already the large government sector are often required a further fiscal expansion to boost the economy. However, the usefulness of discretionary fiscal policy (fiscal multiplier) is not clear at least for short-run stabilization

purposes (Ilzetzki et al.)[19]. All the reasons listed above provide explanation for why the nature of the relationship between government spending and real economic activity changes above the threshold.

Government investment generally has a positive effect below the threshold and a zero effect above it. This suggests that the beneficial impact on government investment on growth dissipates as its level exceeds the threshold and no additional macroeconomic advantage is gained by expanding it even further. This means the economy's performance would be improved by transferring those resources to productive private sector activity. While the results for government consumption show little impact on real GDP growth, in the two countries in which significant results are found, the pattern of reduced effectiveness above the threshold is repeated.

The results for total government expenditure also show very little evidence of positive impact on growth. Australia shows a positive impact above the threshold but that captures just 31 of the 152 observations. Japan shows a positive impact below the threshold but that becomes negative above the threshold. The United States, Canada, and the United Kingdom all experienced negative effects.

[19] Ilzetzki et al. (2010) found the effect of government consumption on economic activity is very small. The medium to long-run effects of increase in government consumption vary considerably. In addition, the composition of government expenditure appears to impact its stimulative effect in developing countries. While increases in government consumption decrease output in developing countries, increases in government investment raise output.

Estimated Coefficients on the Government Spending Variable

Total Government Expenditure

Country	Below Threshold	Above Threshold
United States	-1.77	-0.62
Australia	-0.25	0.52
Canada	-0.43	-0.63
Japan	0.64	-0.20
United Kingdom	0	-0.67

Next, the detailed results for the individual countries are presented. Figures 2.2.1 through 2.2.5 show when the threshold value was observed on the actual data by country and measures of government spending.

2.6.1 Results for the United States

As shown in Table 2.5.1, a single threshold value is found when the threshold variable is the ratio of government consumption to GDP. For the first threshold, F_1 value is 46.80 which is statistically significant at the 1 percent level, with the bootstrap p -value of <0.001. This indicates that there is strong evidence that at least one threshold exists. The second threshold has the F_2 value of 6.73. The null hypothesis of a single threshold is not rejected with a bootstrapped p-value of 0.12. Thereby, it concludes that there exists only one threshold and classifies the data into two regimes.

In addition, at least two threshold values are identified when the ratio of

government investment and total government expenditure to GDP is the threshold variable, respectively. The test statistics F_1 and F_2, along with their p-values are significant at least at the 10 percent level.

Table 2.6.1 (1) shows that government consumption has a significantly negative impact on real GDP growth in the linear model. When the rate of government consumption to GDP exceeds the threshold value of 19.6 percent, it has a significantly negative impact on real GDP growth. Panel (a) of Figure 2.2.1 illustrates that government consumption in the U.S. has been declining since the early 1970s, was 19.6 percent in the second quarter of 1977, and reached 14.9 percent in the fourth quarter of 2008. Table 2.6.1 (2) presents a significantly positive effect of government investment on real GDP growth in the linear model. In both the two and three regime models, government investment has a significantly positive effect below the threshold value of 3.0 percent. However, the effect dissipates above the threshold. Panel (b) of Figure 2.2.1 indicates that government investment was 3.0 percent in the second quarter of 1980 and was 3.3 percent in the fourth quarter of 2008.

As shown in Table 2.6.1 (3), total government expenditure has a significantly negative impact on real GDP growth in the linear model. The impact remains strongly negative below and above the first threshold value of 35.5 percent and the second threshold value of 36.0 percent[20]. The panel (c) of Figure 2.2.1 shows that government total expenditure was 35.5 percent in the second quarter of 1975, 36.0 percent in the third quarter of 1984, and reached 40.7 percent in the fourth quarter of 2008.

[20] The exception is the second regime in the three regime model when the threshold value is between the first and second thresholds (35.5 to 36.0 percent), where total government expenditure has a significantly positive impact on real GDP growth. The second regime only contains 7 observations.

In addition, private investment and labor force growth appear to be positively related to real GDP growth in the linear model for all three measures of government spending and across regimes for most cases.

From the estimated threshold values, it appears to be that the U.S. spent less than the threshold value on government consumption, while overspent on government investment slightly and total government expenditure quite a lot in the fourth quarter of 2008. Figure 2.1.1 illustrates that the U.S. real GDP growth has a downward trend after reaching its peak in the mid-1980s. This might suggest the presence of crowding out. Transferring government resources to the private sector would lead to the economy's better macroeconomic activity.

2.6.2 Results for Australia

A single threshold is found when government consumption to GDP ratio is the threshold variable. Table 2.6.2 (1) shows that government consumption has a positive impact on real GDP growth in the linear model as well as below the threshold of 19.0 percent, while it has a negative impact above the threshold value. However, none of the coefficients of government consumption variable is statistically significant. As shown in the panel (a) of Figure 2.2.2, government consumption was 19.0 percent in the first quarter of 1987 and it has been falling after reaching its peak in the third quarter of 1991, and was 18.1 percent at the fourth quarter of 2008.

Moreover, two thresholds are identified when the ratio of government investment to GDP is the threshold variable. As given in Table 2.6.2 (2), it appears that government

investment has a positive effect on real GDP growth below the threshold value of 2.3 percent, but the effect becomes ambiguous above the threshold in the two regime model. This might be the evidence of crowding out. The result also suggests a strong positive impact of government investment above the second threshold value of 2.6 percent in the three regime (with two thresholds) model. The panel (b) of Figure 2.2.2 shows that government investment was 2.3 percent in the second quarter of 2002, 2.6 percent in the fourth quarter of 1971, and was also roughly 2.6 percent in recent years.

Finally, there is a single threshold found when the ratio of total government expenditure to GDP is the threshold variable. Total government expenditure has a strong negative impact on real GDP growth below the threshold of 37.6 percent, but the impact becomes strongly positive above the threshold. The positive impact of total government expenditure above the threshold is the opposite result from what has been observed in other countries. As previously mentioned, however, it can be explained by the small number of observations included above the threshold. The panel (c) of Figure 2.2.2 illustrates that total government expenditure was 37.6 percent in the first quarter of 1984 and was 36.3 percent in the fourth quarter of 2008. Moreover, private investment as a ratio to GDP is positively related to real GDP growth.

The estimated threshold values indicate that in recent years Australia has spent less than the threshold value on government consumption and total government expenditure by about 1 percent of GDP, while the level of government investment has been very close to the threshold value.

2.6.3 Results for Canada

When the ratio of government consumption to GDP is the threshold variable, as shown in Table 2.6.3 (1), a single threshold is identified. Although government consumption has a strong negative effect on real GDP growth in the linear model, the coefficients of government consumption variable is not significantly different from zero below and above the threshold of 24.2 percent. The panel (a) of Figure 2.2.3 presents a downward trend of government consumption, in particular after the mid-1990s. Government consumption was 24.2 percent in the early 1970s and was 20.3 percent in the fourth quarter of 2008.

On the other hand, two thresholds are found when the ratio of government investment to GDP is the threshold variable. Table 2.6.3 (2) shows that government investment has a positive impact on real GDP growth below the threshold of 2.3 percent. However, the impact dissipates above the threshold. The same result applies to the second threshold value of 2.6 percent. This result might be capturing the presence of crowding out effect. The panel (b) of Figure 2.2.3 illustrates that government investment was 2.3 percent in the second quarter of 1996, 2.6 percent at the third quarter of 2003, and was 3.5 percent in the fourth quarter of 2008.

Finally, there are two thresholds identified when total government expenditure to GDP ratio is the threshold variable. As given in Table 2.6.3 (3), total government expenditure has a strong negative effect on real GDP growth in the linear model as well as below and above the threshold value of 46.1 percent. This also applies to the second threshold of 48.3 percent. As shown in the panel (c) of Figure 2.2.3, total government

expenditure was 46.1 and 48.3 percent in the first quarter of 1988 and the third quarter of 1995, respectively. Total government expenditure has been falling since the early 1990s and it was 41.2 percent in the fourth quarter of 2008. Moreover, labor force growth appears to be strongly related to real GDP growth.

From the estimated threshold values, Canada spent less than the threshold value on both government consumption and total government expenditure while overspent on government investment. The presence of crowding out is detected on government investment. The country's economic activity would be improved by adjusting the level of government investment and reallocating the resources to the private sector.

2.6.4 Results for Japan

As mentioned earlier, Japan has the lowest threshold value of 14.7% among five countries when the ratio of government consumption to GDP is the threshold variable. Table 2.6.4 (1) shows that the estimated coefficient of government consumption variable is positive below and above the first threshold value of 14.7 percent as well as the second threshold value of 15.2 percent. The result also indicates that the magnitude of the impact falls as the level of government consumption rises[21]. The panel (a) of Figure 2.2.4 provides that government consumption was 14.7 percent in the third quarter of 1988 and 15.2 percent at the first quarter of 1997. It has been drastically rising after the late 1990s and reached 18.3 percent in the fourth quarter of 2008.

[21] The coefficient of the threshold value in the first regime is 6.77 and that of the second regime is 0.92 in the two regime model, and the coefficient of the third regime is 1.49 in the three regime model.

Moreover, when the ratio of government investment to GDP is the threshold variable, Japan's estimated threshold value is the highest of 8.5 percent among five countries. Unlike other four countries, as shown in Table 2.6.4 (2), government investment has a positive effect on real GDP growth above the threshold value, but the effect is a negative and insignificant below the threshold. This result is consistent with the idea that government investment may complement private investment in the medium-and long-term. In the medium to long-run, government investment, for example infrastructure investment, can enhance the productivity of private investment (Mitra 2006). As given in the panel (b) of Figure 2.2.4, government investment has started at a very high level compared to other countries and experienced a persistent decline since the late 1970s. It was 8.5 percent in the early 1980s and reached 3.5 percent in the fourth quarter of 2008.

Finally, two thresholds are identified when the ratio of total government expenditure to GDP is the threshold variable. As given in Table 2.6.4 (3), total government expenditure has a positive impact below the threshold value of 34.3 percent but the impact becomes negative above the threshold. This result also applies to the second threshold value of 37.0 percent. The panel (c) of Figure 2.2.4 illustrates an upward trend of total government expenditure for the past four decades. Total government expenditure was 34.3 and 37.0 percent in the third quarter of 1981 and the second quarter of 1996 respectively, and was 38.3 percent in the fourth quarter of 2008.

The estimated threshold values indicate that the current level of both government consumption and total government expenditure are higher than the threshold values, while that of government investment is much lower than the threshold value.

2.6.5 Results for the United Kingdom

The UK has a single threshold for all three measures of government spending. When government consumption to GDP ratio is a threshold variable, the UK has the highest threshold value of 26.8 percent among five countries. As shown in Table 2.6.5 (1), the impact of government consumption on real GDP growth is negative in the near model, and below and above the thresholds, although neither of these estimated coefficients is statistically significant. In the panel (a) of Figure 2.2.5, government consumption was 26.8 percent in the second quarter of 1972. It has been sharply falling since the late 1970s and reached 21.1 percent in the fourth quarter of 2008.

On the other hand, government investment in the UK has the lowest threshold value of 1.4 percent. As given in Table 2.6.5 (2), the effects of government investment on real GDP growth are significantly positive below the threshold value, but become insignificant above the threshold. This might indicate a presence of crowding out. The panel (b) of Figure 2.2.5 shows that government investment was 1.4 percent in the fourth quarter of 2001 and was 2.5 percent in the fourth quarter of 2008.

Total government expenditure has a strong negative impact on real GDP growth above the threshold value of 45.4 percent as given in Table 2.6.5 (3). The panel (c) of Figure 2.2.5 shows that total government expenditure was 45.4 percent in the second quarter of 1986 and reached 49.1 percent in the fourth quarter of 2008.

From the estimated threshold values, the UK spent less than the threshold value on government consumption, while spent more on government investment and total government expenditure. In particular, government investment shows the presence of

crowding out effect. It appears that there is a room for reallocating government resources to improve the country's economic activity.

2.7 Conclusion

My research investigates whether there is a nonlinear relationship between government spending and macroeconomic performances for five OECD countries. I employ the threshold model adopting Hansen's method to analyze a possible nonlinear relationship between three measures of government spending and real GDP growth.

This approach has several advantages. First, the threshold model allows analyzing a possible nonlinear relationship when there is no theoretical base for an explicit functional form. The results using an alternative approach which is estimating a quadratic model indicate that the appropriate functional form depends on the measure of government spending used. In other words, the shape of the nonlinearity needs to be confirmed by estimating different functional forms. On the other hand, the threshold model tests for the presence of nonlinearity without requiring assumptions on a specific functional form and it defaults to the linear model in case that nonlinearity does not exist.

In addition, fiscal policy has a tendency to affect the country's economic performance through many different channels including the real sector productivity and private sector performance. Unlike the quadratic model in which only the parameter of government spending variable changes, the threshold model allows all the parameters of the variables included in the model to change depending on whether the ratio of government spending to GDP is below or above the threshold value.

Main results from the analysis confirm that first, there is strong evidence that a nonlinear relationship exists for all three measures of government spending in five countries.

Second, the pattern of results suggests that there appears to be a "turning point" in the government spending and real GDP growth relationship, and thereby support the concept that an optimal government size may exist. In most cases, the impacts of government spending on real GDP growth are either insignificant or negative above the threshold.

Third, compositional effects seem important when examining government spending. The results show that the impact on government investment on real GDP growth has a quite different pattern from that for government consumption. Government investment has a positive impact on real GDP growth below the threshold value but the impact becomes ambiguous above the threshold. In contrast, it is much less obvious that government consumption has a positive role in increasing real GDP growth except for Japan.

Finally, the results indicate large country-specific variations in terms of the pattern of results, which would probably stem from each country's fiscal experience. In addition, countries with relatively high average ratios of government spending tend to have higher threshold values. This suggests that countries with relatively high average government spending ratios spend more because the beneficial aspects of government spending are more extensive.

Achieving more efficient allocation of government resources and transferring the

resources to more productive private sector activities would allow for a country to avoid economic loss and improve the long-term economic performance. The estimations here may provide a starting point for examining this even further.

Table 2.1 Descriptive Statistics of Main Variables (1970 Q1 -2008 Q4)

		Real GDP growth rates (annual) GDPV_gr	Labor force growth rates (annual) LF_gr	Govt. consump exp growth rates (annual) CGV_gr	Govt. investment growth rates (annual) IGV_gr	Total govt. exp growth rates (annual) YPG_con_gr	Private investment (% of GDP) IPV_Y	Govt. consump exp (% of GDP) CGV_Y	Govt. investment (% of GDP) IGV_Y	Total govt. exp (% of GDP) YPGT_Y
United States	**Minimum**	-0.03	0.00	-0.02	-0.14	0.00	12.25	14.25	2.53	31.08
	Mean	0.03	0.02	0.02	0.03	0.03	15.54	17.64	3.15	35.60
	Median	0.03	0.02	0.02	0.03	0.03	14.82	18.03	3.14	36.23
	Maximum	0.08	0.04	0.06	0.17	0.09	19.61	23.43	3.83	40.74
	Std dev.	0.02	0.01	0.02	0.06	0.02	2.13	2.42	0.27	2.08
	No.	152	152	152	152	152	156	156	156	156
Australia	**Minimum**	-0.03	0.00	-0.04	-0.20	-0.05	15.12	15.37	1.60	24.95
	Mean	0.03	0.02	0.03	0.03	0.04	18.94	18.08	2.27	34.55
	Median	0.04	0.02	0.03	0.04	0.03	18.22	18.05	2.18	34.95
	Maximum	0.08	0.04	0.12	0.26	0.20	27.74	20.27	3.23	39.90
	Std dev.	0.02	0.01	0.03	0.09	0.04	2.68	0.97	0.33	3.47
	No.	152	152	152	152	152	156	156	156	156
Canada	**Minimum**	-0.04	0.00	-0.03	-0.08	-0.04	13.93	19.08	1.90	35.28
	Mean	0.03	0.02	0.02	0.04	0.03	16.72	22.69	2.41	43.45
	Median	0.03	0.02	0.03	0.04	0.03	16.48	23.51	2.37	42.11
	Maximum	0.08	0.06	0.08	0.16	0.13	20.84	26.09	3.48	53.46
	Std dev.	0.02	0.01	0.02	0.06	0.03	1.67	2.26	0.31	4.65
	No.	152	152	152	152	152	156	156	156	156
Japan	**Minimum**	-0.05	-0.01	-0.01	-0.32	-0.13	16.35	13.31	3.33	20.02
	Mean	0.03	0.01	0.03	0.00	0.04	19.19	15.50	7.39	33.30
	Median	0.03	0.01	0.03	-0.01	0.04	18.90	15.14	7.66	33.82
	Maximum	0.10	0.03	0.13	0.25	0.19	24.33	18.32	10.43	43.37
	Std dev.	0.02	0.01	0.02	0.09	0.05	1.82	1.27	1.69	4.95
	No.	152	152	152	152	152	156	156	156	156
United Kingdom	**Minimum**	-0.04	-0.01	-0.02	-0.57	-0.11	11.77	19.84	-3.47	33.29
	Mean	0.02	0.01	0.02	0.02	0.03	14.02	23.63	1.66	44.00
	Median	0.03	0.01	0.02	0.03	0.02	13.23	23.33	1.54	44.04
	Maximum	0.10	0.03	0.08	0.54	0.20	20.67	28.34	3.20	50.67
	Std dev.	0.02	0.01	0.02	0.18	0.04	1.58	2.81	0.72	3.25
	No.	152	152	152	150	152	156	156	156	156
TOTAL (unweighted sample avg.)	**Minimum**	-0.05	-0.01	-0.04	-0.57	-0.13	11.77	13.31	-3.47	20.02
	Mean	0.03	0.01	0.03	0.02	0.04	16.88	19.51	3.38	38.18
	Median	0.03	0.01	0.02	0.03	0.03	16.95	18.87	2.64	37.35
	Maximum	0.10	0.06	0.13	0.54	0.20	27.74	28.34	10.43	53.46
	Std dev.	0.02	0.01	0.02	0.11	0.04	2.82	3.75	2.23	5.97
	No.	760	760	760	758	760	780	780	780	780

Table 2.2 The Changes of Average Government Size by Decade

	Govt. consump exp (% of GDP) CGV_Y	Govt. investment (% of GDP) IGV_Y	Total govt. exp (% of GDP) YPGT_Y
United States			
1970-79	20.55	2.99	32.77
1980-89	18.61	3.15	36.29
1990-99	16.45	3.24	36.78
2000-08	14.66	3.22	36.67
Australia			
1970-79	17.00	2.67	30.18
1980-89	18.67	2.00	36.20
1990-99	18.75	2.05	36.96
2000-08	17.86	2.37	34.89
Canada			
1970-79	24.83	2.39	38.88
1980-89	23.76	2.16	45.95
1990-99	22.38	2.42	48.33
2000-08	19.46	2.70	40.32
Japan			
1970-79	14.38	9.10	26.91
1980-89	15.13	7.60	33.47
1990-99	15.17	7.55	35.54
2000-08	17.51	5.06	37.73
United Kingdom			
1970-79	26.61	2.41	45.09
1980-89	25.35	1.21	45.68
1990-99	21.95	1.50	42.51
2000-08	20.28	1.53	42.58

Table 2.3 Correlations of Main Variables

United States

	Real GDP growth	Labor force growth	Real govt. consump exp growth	Real govt. investment growth	Real total govt. exp growth	Investment (the ratio to GDP)	Govt. consump exp (the ratio to GDP)	Govt. investment (the ratio to GDP)	Total govt. exp (the ratio to GDP)
Real GDP growth	1								
Labor force growth	0.3093*	1							
Real govt. consump exp growth	-0.1907*	-0.0821	1						
Real govt. investment growth	0.2013*	-0.0167	0.4423*	1					
Real total govt. exp growth	-0.3035*	0.0202	0.4572*	0.3083*	1				
Investment (the ratio to GDP)	0.0951	-0.3401*	0.1665*	0.1889*	-0.1078	1			
Govt. consump exp (the ratio to GDP)	-0.003	0.5839*	-0.1143	-0.2106*	0.2006*	-0.8697*	1		
Govt. investment (the ratio to GDP)	-0.1528	-0.5103*	0.1910*	0.1938*	0.0991	-0.0027	-0.0818	1	
Total govt. exp (the ratio to GDP)	-0.2840*	-0.7358*	0.2426*	0.1351	0.1442	0.1773*	-0.5181*	0.4607*	1

Australia

	Real GDP growth	Labor force growth	Real govt. consump exp growth	Real govt. investment growth	Real total govt. exp growth	Investment (the ratio to GDP)	Govt. consump exp (the ratio to GDP)	Govt. investment (the ratio to GDP)	Total govt. exp (the ratio to GDP)
Real GDP growth	1								
Labor force growth	0.047	1							
Real govt. consump exp growth	0.1009	0.1864*	1						
Real govt. investment growth	0.1377	0.1355	0.2738*	1					
Real total govt. exp growth	-0.0247	-0.0627	0.3139*	0.1801*	1				
Investment (the ratio to GDP)	0.1431	0.1882*	-0.081	0.2052*	-0.2542*	1			
Govt. consump exp (the ratio to GDP)	-0.1374	-0.1225	0.1024	0.0368	-0.0898	-0.0555	1		
Govt. investment (the ratio to GDP)	-0.0628	0.1571	0.2307*	0.2954*	0.2206*	-0.026	-0.5827*	1	
Total govt. exp (the ratio to GDP)	-0.0076	-0.1665*	-0.0782	0.0925	-0.0049	0.072	0.8969*	-0.5955*	1

Canada

	Real GDP growth	Labor force growth	Real govt. consump exp growth	Real govt. investment growth	Real total govt. exp growth	Investment (the ratio to GDP)	Govt. consump exp (the ratio to GDP)	Govt. investment (the ratio to GDP)	Total govt. exp (the ratio to GDP)
Real GDP growth	1								
Labor force growth	0.4510*	1							
Real govt. consump exp growth	0.0365	0.4402*	1						
Real govt. investment growth	-0.0586	-0.1817*	0.2640*	1					
Real total govt. exp growth	-0.1852*	0.2560*	0.6224*	0.2211*	1				
Investment (the ratio to GDP)	-0.1171	-0.0845	0.1793*	0.3865*	-0.1757*	1			
Govt. consump exp (the ratio to GDP)	-0.0957	0.3064*	0.1312	-0.2917*	0.5124*	-0.6687*	1		
Govt. investment (the ratio to GDP)	-0.2624*	-0.2683*	0.0966	0.3737*	-0.0498	0.3496*	-0.2926*	1	
Total govt. exp (the ratio to GDP)	-0.3738*	-0.6522*	-0.4226*	-0.0847	-0.0759	-0.2840*	0.1887*	-0.2059*	1

Japan

	Real GDP growth	Labor force growth	Real govt. consump exp growth	Real govt. investment growth	Real total govt. exp growth	Investment (the ratio to GDP)	Govt. consump exp (the ratio to GDP)	Govt. investment (the ratio to GDP)	Total govt. exp (the ratio to GDP)
Real GDP growth	1								
Labor force growth	0.5700*	1							
Real gov consump exp growth	0.3333*	0.2415*	1						
Real gov investment growth	0.3603*	0.3554*	0.4403*	1					
Real total gov exp growth	0.2889*	0.2125*	0.3945*	0.3756*	1				
Investment (the ratio to GDP)	0.3272*	0.4101*	-0.0269	0.2117*	0.141	1			
Gov consump exp (the ratio to GDP)	-0.4965*	-0.6572*	-0.2892*	-0.5089*	-0.5100*	-0.5326*	1		
Gov investment (the ratio to GDP)	0.3297*	0.3864*	0.4959*	0.5608*	0.4931*	-0.0806	-0.7098*	1	
Total gov exp (the ratio to GDP)	-0.5864*	-0.4253*	-0.3374*	-0.4528*	-0.4718*	-0.4348*	0.7530*	-0.4989*	1

United Kingdom

	Real GDP growth	Labor force growth	Real govt. consump exp growth	Real govt. investment growth	Real total govt. exp growth	Investment (the ratio to GDP)	Govt. consump exp (the ratio to GDP)	Govt. investment (the ratio to GDP)	Total govt. exp (the ratio to GDP)
Real GDP growth	1								
Labor force growth	0.2122*	1							
Real govt. consump exp growth	-0.0524	0.1043	1						
Real govt. investment growth	0.1447	0.0407	0.1871*	1					
Real total govt. exp growth	-0.1772*	0.02	0.3881*	0.3784*	1				
Investment (the ratio to GDP)	0.1377	0.2946*	0.141	0.2566*	0.0215	1			
Govt. consump exp (the ratio to GDP)	-0.2500*	-0.1547	-0.0337	-0.2720*	-0.0633	-0.8563*	1		
Govt. investment (the ratio to GDP)	-0.0302	-0.1008	0.2903*	0.1428	0.3093*	-0.4113*	0.2779*	1	
Total govt. exp (the ratio to GDP)	-0.3753*	-0.0765	-0.1053	-0.0597	0.2143*	-0.5807*	0.6509*	0.1647*	1

Notes:
** denotes the significance level at 5 percent.*

Table 2.4 Definitions of Variables

Variable name	Variable code	Definition
Real GDP growth	GDPV_gr	Real GDP growth rates
Labor force growth	LF_gr	Labor force growth rates
Government consumption expenditure	CGV_gr	Real government final consumption expenditure growth rates
Government investment growth	IGV_gr	Real government gross fixed capital formation (GFCF) growth rates
Total government expenditure growth	YPG_con_gr	Real governemtn expenditure growth rates
Investment	IPV_Y	Real private gross fixed capital formation (the ratio to real GDP)
Government comsumption expenditure	CGV_Y	Real government final consump expenditure (the ratio to real GDP)
Government investment	IGV_Y	Real government gross fixed capital formation (the ratio to real GDP)
Total government expenditure	YPGT_Y	Real total goverment expenditure (the ratio to real GDP)

Data source:
OECD Economic Outlook Database

Figure 2.1.1 Time Path of Main Variables: The United States (1971 Q1 – 2008 Q4)

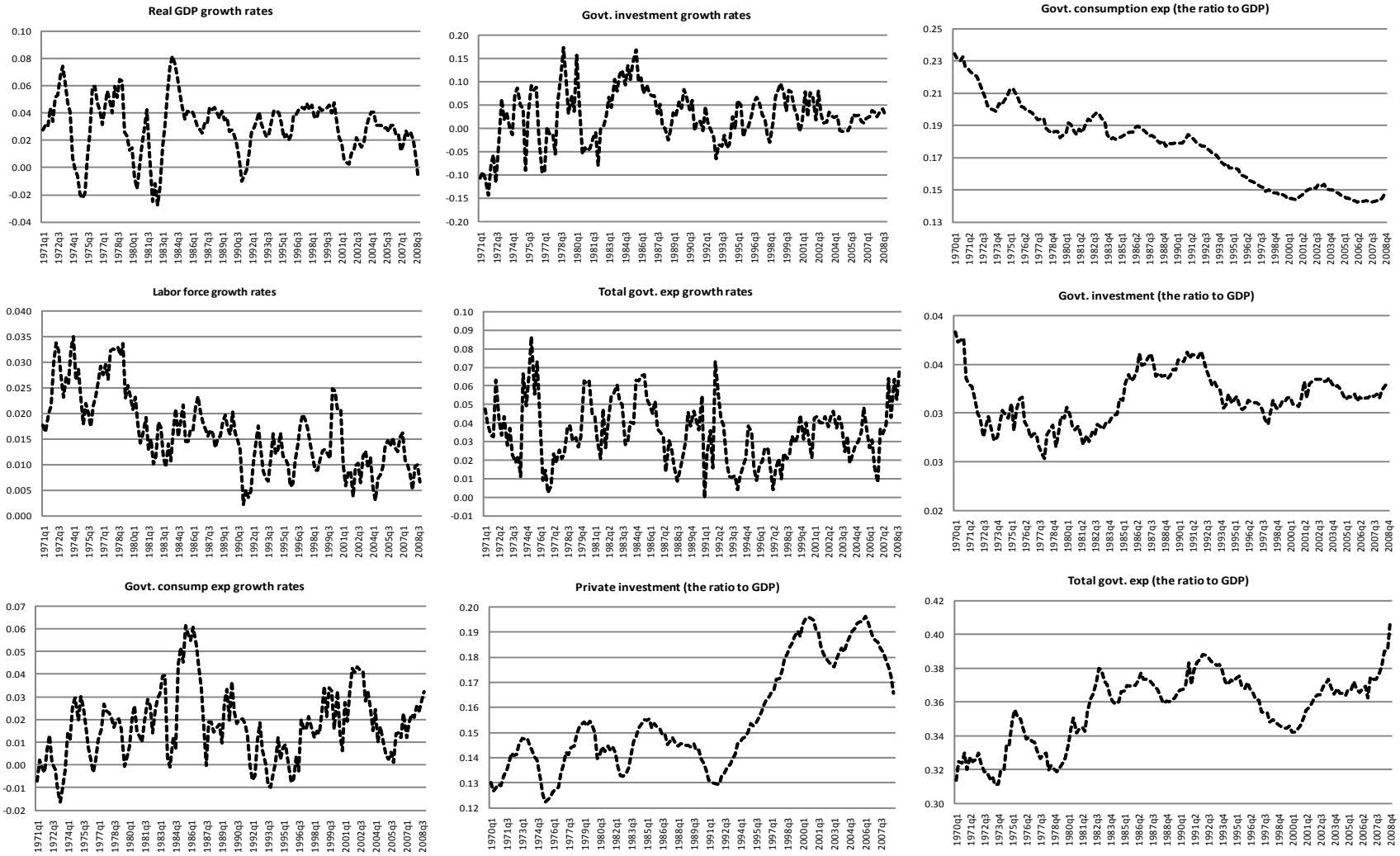


Figure 2.1.2 Time Path of Main Variables: Australia (1971 Q1 – 2008 Q4)

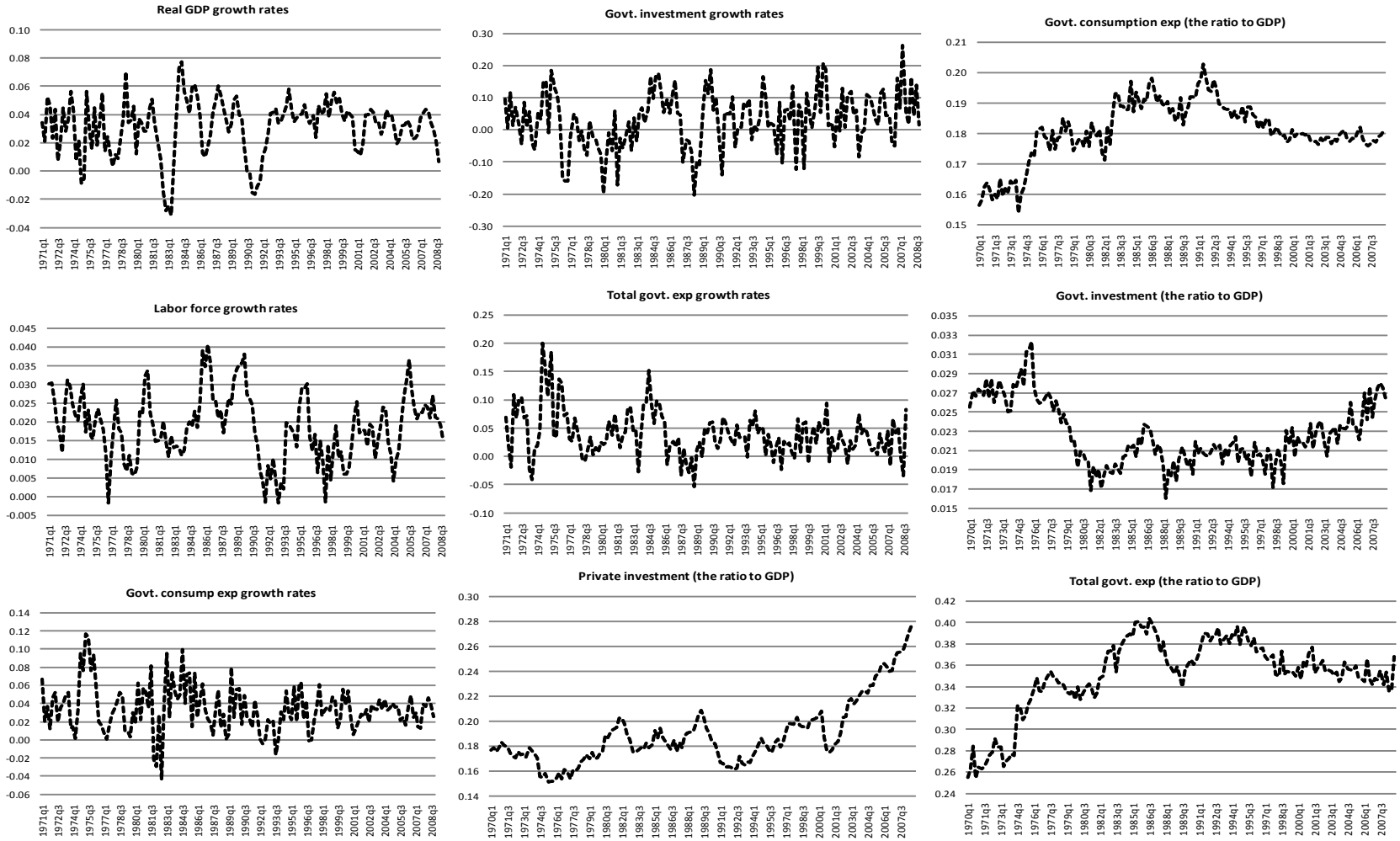


Figure 2.1.3 Time Path of Main Variables: Canada (1971 Q1 – 2008 Q4)

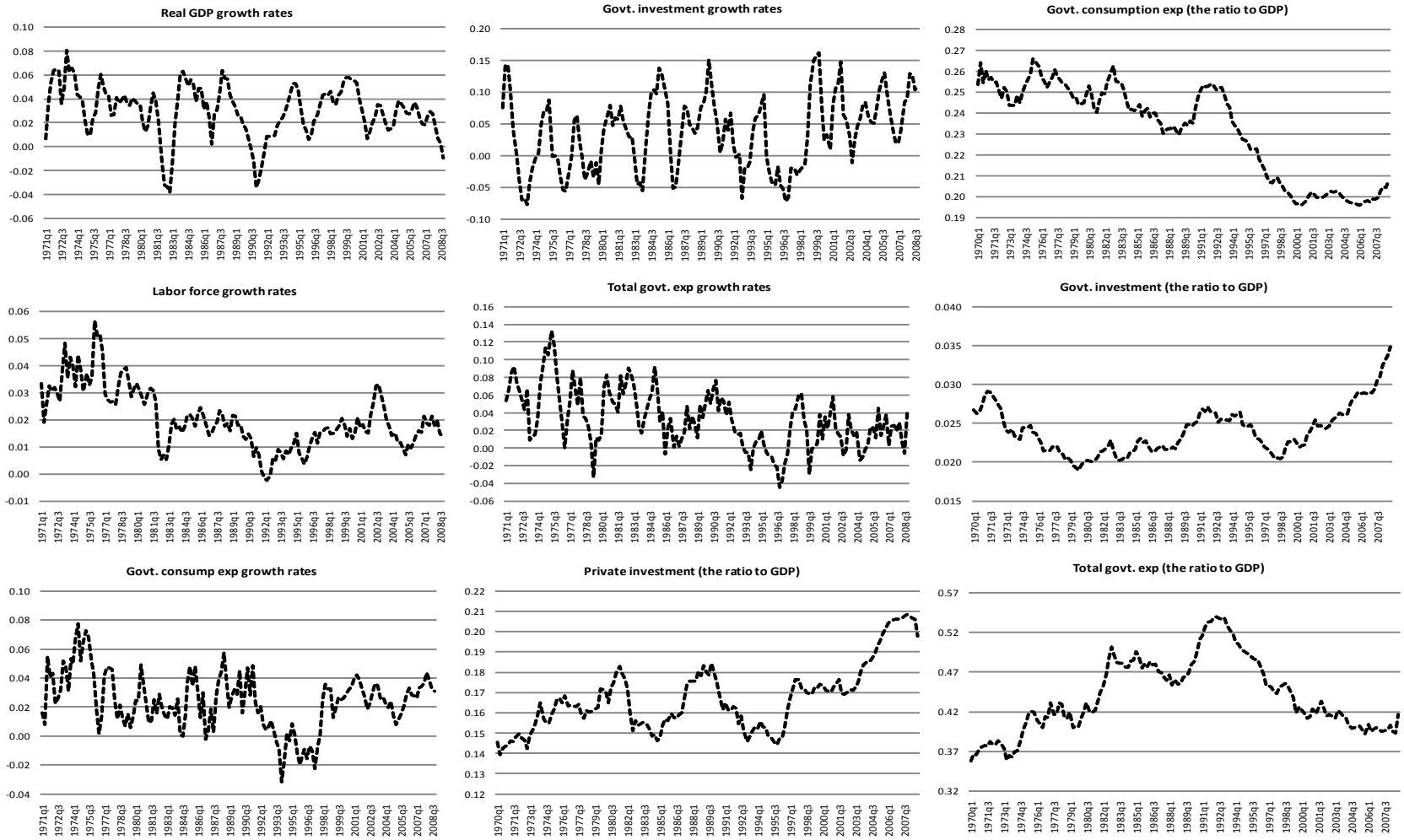


Figure 2.1.4 Time Path of Main Variables: Japan (1971 Q1 – 2008 Q4)

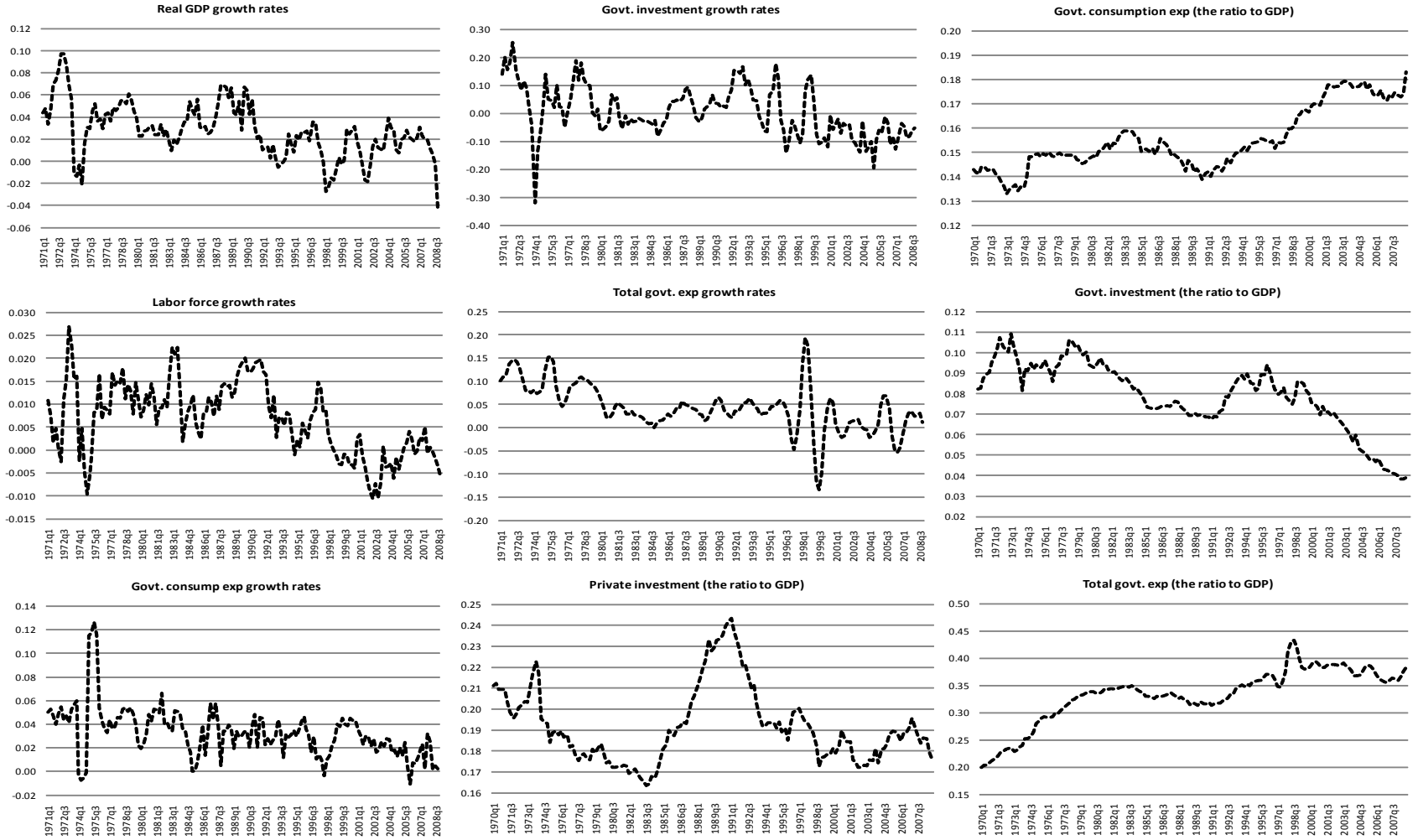


Figure 2.1.5 Time Path of Main Variables: The United Kingdom (1971 Q1 – 2008 Q4)

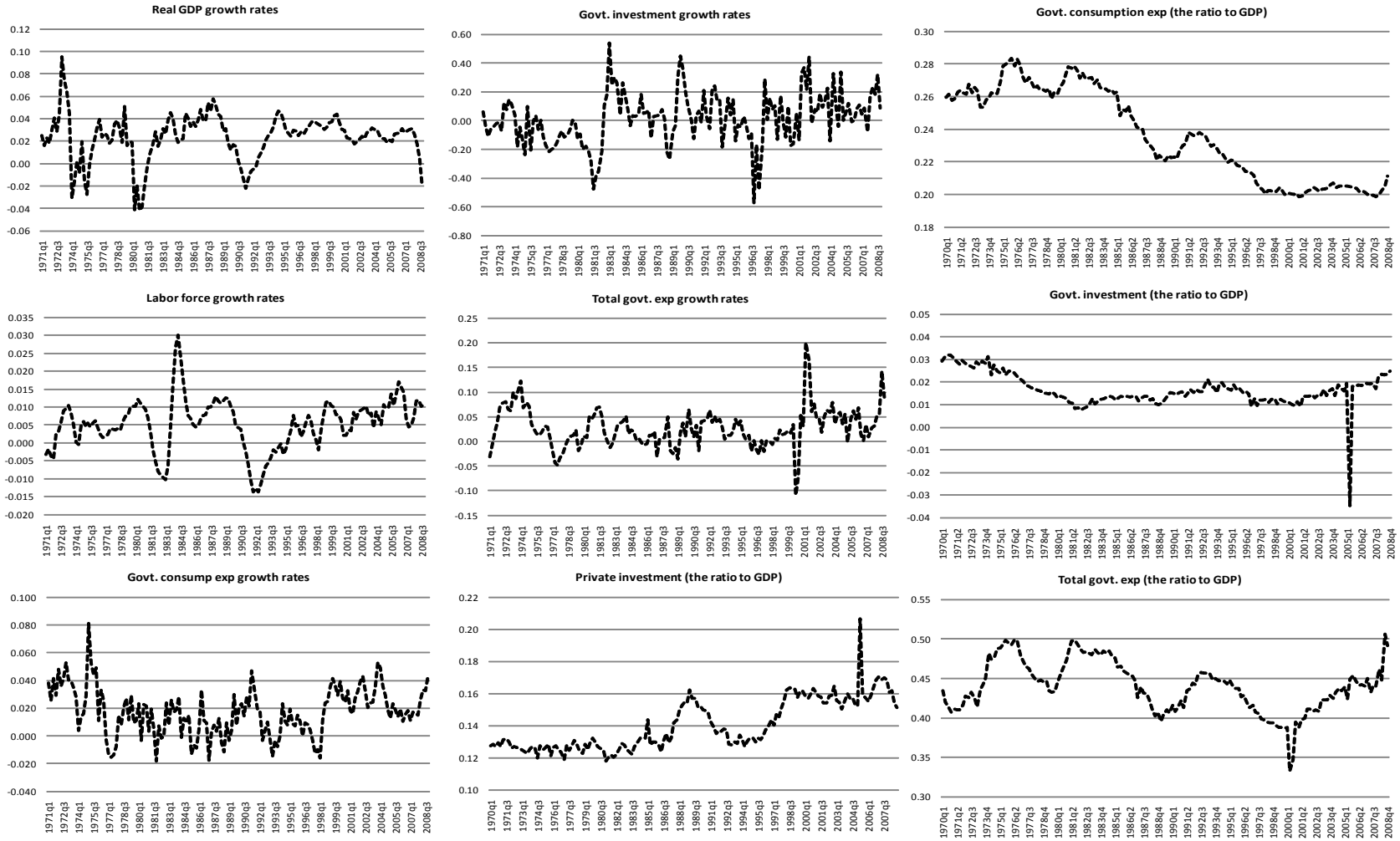


Table 2.5.1 Threshold Test Results for the United States

1.) Threshold variable: Government consumption expenditure (CGV_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.196	91st	46.800	<0.001	[0.194, 0.196]
2nd threshold	0.198	94th	6.728	0.119	

2.) Threshold variable: Government investment (IGV_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.030	19th	14.318	0.029	[0.029, 0.033]
2nd threshold	0.031	37th	25.248	0.001	[0.030, 0.031]

3.) Threshold variable: Total government expenditure (YPGT_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.355	38th	16.004	0.004	[0.351, 0.366]
2nd threshold	0.360	44th	16.880	0.086	[0.360, 0.372]

Table 2.5.2 Threshold Test Results for Australia

1.) Threshold variable: Government consumption expenditure (CGV_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.190	99th	21.463	0.029	[0.189, 0.190]

2.) Threshold variable: Government investment (IGV_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.023	61st	11.594	0.002	[0.021, 0.027]
2nd threshold	0.026	94th	8.892	0.036	[0.024, 0.027]

3.) Threshold variable: Total government expenditure (YPGT_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.376	93rd	21.334	<0.001	[0.369, 0.379]
2nd threshold	0.377	95th	12.005	0.254	

Table 2.5.3 Threshold Test Results for Canada

1.) Threshold variable: Government consumption expenditure (CGV_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.242	70th	60.350	<0.001	[0.241, 0.243]
2nd threshold	0.249	99th	9.003	0.102	[0.246, 0.249]

2.) Threshold variable: Government investment (IGV_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.023	47th	11.835	0.009	[0.021, 0.025]
2nd threshold	0.026	81st	8.954	0.033	[0.021, 0.027]

3.) Threshold variable: Total government expenditure (YPGT_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.461	76th	43.757	<0.001	[0.426, 0.461]
2nd threshold	0.483	98th	19.997	0.006	[0.476, 0.484]

Table 2.5.4 Threshold Test Results for Japan

1.) Threshold variable: Government consumption expenditure (CGV_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.147	18th	32.625	0.001	[0.143, 0.148]
2nd threshold	0.152	54th	15.010	<0.001	[0.149, 0.157]

2.) Threshold variable: Government investment (IGV_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.085	80th	42.451	<0.001	[0.084, 0.089]
2nd threshold	0.087	90th	4.879	0.111	

3.) Threshold variable:Total government expenditure (YPGT_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.343	54th	52.535	<0.001	[0.334, 0.347]
2nd threshold	0.370	91st	8.397	0.023	[0.334, 0.382]

Table 2.5.5 Threshold Test Results for the United Kingdom

1.) Threshold variable: Government consumpion expenditure (CGV_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.268	98th	73.060	<0.001	[0.266, 0.268]

2.) Threshold variable: Government investment (IGV_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.014	29th	10.290	0.010	[0.012, 0.024]
2nd threshold	0.017	64th	5.893	0.117	

3.) Threshold variable: Total government expenditure (YPGT_Y)

	Threshold regime (the ratio to GDP)	Percentile	F value	Bootstrap p-value	95% confidence interval
1st threshold	0.454	78th	58.295	<0.001	[0.453, 0.462]
2nd threshold	0.456	80th	15.937	0.330	

Table 2.6.1 (1) Regression Results for the United States with Government Consumption Expenditure

Threshold variable: Government consumption expenditure (CGV_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 91st percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.196	[2] >0.196
Investment / GDP	0.233***	0.113	-0.178
	[3.21]	[1.62]	[0.25]
Labor force growth	1.079***	1.285***	0.644
	[5.33]	[6.03]	[0.72]
Gov consump growth x Gov consump / GDP	-1.572***	-0.61	-8.317***
	[2.70]	[1.17]	[5.35]
Constant	-0.02	-0.005	0.05
	[1.53]	[0.36]	[0.56]
R2	0.18	0.21	0.67
No. of obs	152	124	28

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.1 (2) Regression Results for the United States with Government Investment

Threshold variable: Government investment (IGV_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 19th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.030	[2] >0.030
Investment / GDP	0.193***	0.948***	0.136**
	[2.63]	[2.76]	[2.02]
Labor force growth	1.056***	1.331***	0.782**
	[5.14]	[3.02]	[2.47]
Gov inv growth x Gov inv / GDP	1.853**	5.441***	-0.142
	[2.01]	[2.80]	[0.19]
Constant	-0.019	-0.134**	-0.005
	[1.46]	[2.53]	[0.38]
R2	0.16	0.38	0.09
No. of obs	152	43	109

2nd threshold: 37th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.030	[2] >0.030 & <=0.0310	[3] >0.0310
Investment / GDP	0.193***	0.948***	0.561***	0.066
	[2.63]	[2.76]	[3.06]	[1.11]
Labor force growth	1.056***	1.331***	-0.584	1.610***
	[5.14]	[3.02]	[1.14]	[5.52]
Gov inv growth x Gov inv / GDP	1.853**	5.441***	-2.059	0.057
	[2.01]	[2.80]	[0.79]	[0.10]
Constant	-0.019	-0.134**	-0.051	-0.003
	[1.46]	[2.53]	[1.51]	[0.29]
R2	0.16	0.38	0.43	0.33
No. of obs	152	43	21	88

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.1 (3) Regression Results for the United States with Total Government Expenditure

Threshold variable: Total government expenditure (YPGT_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 38th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.355	[2] >0.355
Investment / GDP	0.190***	0.223*	0.117
	[2.72]	[1.90]	[1.34]
Labor force growth	0.998***	0.811**	1.819***
	[4.55]	[2.45]	[4.95]
Gov exp growth x Gov exp / GDP	-0.951***	-1.766***	-0.617**
	[3.60]	[4.22]	[2.39]
Constant	-0.005	0.001	-0.006
	[0.33]	[0.06]	[0.38]
R2	0.22	0.36	0.21
No. of obs	152	61	91

2nd threshold: 44th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.355	[2] >0.355 & <=0.360	[3] >0.360
Investment / GDP	0.190***	0.223*	-2.259*	0.161*
	[2.72]	[1.90]	[2.47]	[1.88]
Labor force growth	0.998***	0.811**	-0.816	1.416***
	[4.55]	[2.45]	[0.29]	[4.32]
Gov exp growth x Gov exp / GDP	-0.951***	-1.766***	5.034*	-0.518*
	[3.60]	[4.22]	[2.55]	[1.97]
Constant	-0.005	0.001	0.361	-0.01
	[0.33]	[0.06]	[2.16]	[0.64]
R2	0.22	0.36	0.91	0.17
No. of obs	152	61	7	84

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.2 (1) Regression Results for Australia with Government Consumption Expenditure

Threshold variable: Government consumption expenditure (CGV_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 99th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.190	[2] >0.190
Investment / GDP	0.110**	0.041	1.420**
	[2.16]	[0.84]	[2.45]
Labor force growth	-0.003	-0.243*	0.001
	[0.02]	[1.68]	[0.00]
Gov consump growth x Gov consump / GDP	0.445	0.36	-0.146
	[1.06]	[0.83]	[0.10]
Constant	0.008	0.028***	-0.232**
	[0.73]	[2.80]	[2.53]
R2	0.03	0.02	0.34
No. of obs	152	127	25

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.2 (2) Regression Results for Australia with Government Investment

Threshold variable: Government investment (IGV_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 61st percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.023	[2] >0.023
Investment / GDP	0.087	0.321**	0.06
	[1.61]	[2.26]	[1.04]
Labor force growth	0.02	0.340*	-0.580***
	[0.12]	[1.84]	[2.67]
Gov inv growth x Gov inv / GDP	0.933	2.529**	0.767
	[1.24]	[2.34]	[0.82]
Constant	0.014	-0.034	0.028**
	[1.23]	[1.27]	[2.34]
R2	0.03	0.13	0.1
No. of obs	152	91	61

2nd threshold: 94th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.023	[2] >0.023 & <=0.026	[3] >0.026
Investment / GDP	0.087	0.321**	0.132*	-0.004
	[1.61]	[2.26]	[2.02]	[0.05]
Labor force growth	0.02	0.340*	-0.761***	0.443
	[0.12]	[1.84]	[3.61]	[0.89]
Gov inv growth x Gov inv / GDP	0.933	2.529**	0.335	2.969*
	[1.24]	[2.34]	[0.41]	[1.75]
Constant	0.014	-0.034	0.02	0.009
	[1.23]	[1.27]	[1.42]	[0.49]
R2	0.03	0.13	0.23	0.16
No. of obs	152	91	35	26

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.2 (3) Regression Results for Australia with Total Government Expenditure

Threshold variable: Total government expenditure (YPGT_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 93rd percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.376	[2] >0.376
Investment / GDP	0.105**	0.075	1.720***
	[2.00]	[1.49]	[3.74]
Labor force growth	0.047	-0.137	-0.435
	[0.28]	[0.77]	[1.38]
Gov exp growth x Gov exp / GDP	0.035	-0.246*	0.518**
	[0.26]	[1.68]	[2.60]
Constant	0.01	0.021*	-0.271***
	[0.91]	[1.91]	[3.47]
R2	0.02	0.06	0.52
No. of obs	152	121	31

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.3 (1) Regression Results for Canada with Government Consumption Expenditure

Threshold variable: Government consumption expenditure (CGV_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 70th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.242	[2] >0.242
Investment / GDP	-0.069	-0.350***	-0.943***
	[0.80]	[4.42]	[2.76]
Labor force growth	1.078***	0.627***	1.435***
	[6.20]	[3.32]	[7.61]
Gov consump growth x Gov consump / GDP	-1.059***	0.361	-0.655
	[2.82]	[0.87]	[1.49]
Constant	0.025	0.082***	0.142**
	[1.62]	[5.53]	[2.62]
R2	0.25	0.24	0.57
No. of obs	152	100	52

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.3 (2) Regression Results for Canada with Government Investment

Threshold variable: Government investment (IGV_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 47th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.023	[2] >0.023
Investment / GDP	-0.128	0.253	-0.124
	[1.33]	[1.02]	[1.06]
Labor force growth	0.875***	0.774***	0.846***
	[6.04]	[3.11]	[4.50]
Gov inv growth x Gov inv / GDP	0.597	3.646***	-0.842
	[0.53]	[2.76]	[0.53]
Constant	0.033*	-0.026	0.032
	[1.96]	[0.58]	[1.61]
R2	0.21	0.2	0.26
No. of obs	152	75	77

2nd threshold: 81st percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.023	[2] >0.023 & <=0.026	[3] >0.026
Investment / GDP	-0.128	0.253	-0.163	-0.162
	[1.33]	[1.02]	[0.56]	[1.24]
Labor force growth	0.875***	0.774***	0.855***	1.081***
	[6.04]	[3.11]	[4.40]	[2.76]
Gov inv growth x Gov inv / GDP	0.597	3.646***	-4.407*	1.232
	[0.53]	[2.76]	[1.72]	[0.62]
Constant	0.033*	-0.026	0.036	0.035
	[1.96]	[0.58]	[0.81]	[1.36]
R2	0.21	0.2	0.52	0.23
No. of obs	152	75	38	39

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.3 (3) Regression Results for Canada with Total Government Expenditure

Threshold variable: Total government expenditure (YPGT_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 76th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.461	[2] >0.461
Investment / GDP	-0.185**	-0.458***	-0.834***
	[2.24]	[4.02]	[2.80]
Labor force growth	0.981***	0.238	2.427***
	[7.33]	[1.53]	[5.44]
Gov exp growth x Gov exp / GDP	-0.553***	-0.427***	-0.630***
	[4.71]	[3.76]	[2.97]
Constant	0.049***	0.114***	0.131***
	[3.33]	[5.03]	[2.92]
R2	0.33	0.28	0.53
No. of obs	152	103	49

2nd threshold: 98th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.461	[2] <0.461 & <=0.483	[3] >0.483
Investment / GDP	-0.185**	-0.458***	-0.956***	-1.091
	[2.24]	[4.02]	[4.13]	[1.59]
Labor force growth	0.981***	0.238	2.870***	2.293***
	[7.33]	[1.53]	[3.73]	[2.88]
Gov exp growth x Gov exp / GDP	-0.553***	-0.427***	0.109	-1.080***
	[4.71]	[3.76]	[0.33]	[3.84]
Constant	0.049***	0.114***	0.133***	0.182*
	[3.33]	[5.03]	[3.54]	[1.76]
R2	0.33	0.28	0.58	0.65
No. of obs	152	103	24	25

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.4 (1) Regression Results for Japan with Government Consumption Expenditure

Threshold variable: Government consumption expenditure (CGV_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 18th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.147	[2] >0.147
Investment / GDP	0.205**	-0.317*	0.241
	[2.03]	[1.78]	[1.33]
Labor force growth	1.433***	1.420***	1.294***
	[5.71]	[2.86]	[5.62]
Gov consump growth x Gov consump / GDP	1.587***	6.770***	0.916**
	[3.31]	[4.91]	[2.24]
Constant	-0.029	0.062*	-0.034
	[1.53]	[1.79]	[0.99]
R2	0.38	0.57	0.3
No. of obs	152	39	113

2nd threshold: 54th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.147	[2] >0.147 & <=0.152	[3] >0.152
Investment / GDP	0.205**	-0.317*	-0.011	0.303*
	[2.03]	[1.78]	[0.04]	[1.72]
Labor force growth	1.433***	1.420***	1.579***	0.651***
	[5.71]	[2.86]	[2.77]	[2.65]
Gov consump growth x Gov consump / GDP	1.587***	6.770***	0.345	1.488*
	[3.31]	[4.91]	[0.59]	[1.75]
Constant	-0.029	0.062*	0.02	-0.049
	[1.53]	[1.79]	[0.33]	[1.42]
R2	0.38	0.57	0.17	0.17
No. of obs	152	39	40	73

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.4 (2) Regression Results for Japan with Government Investment

Threshold variable: Government investment (IGV_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 80th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.085	[2] >0.0853
Investment / GDP	0.133	0.280**	0.624***
	[1.47]	[2.38]	[3.76]
Labor force growth	1.418***	1.099***	1.976***
	[5.77]	[4.50]	[5.67]
Gov inv growth x Gov inv / GDP	0.762***	-0.429	1.122***
	[3.01]	[0.97]	[3.29]
Constant	-0.008	-0.039*	-0.099***
	[0.51]	[1.78]	[3.44]
R2	0.38	0.32	0.66
No. of obs	152	107	45

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.4 (3) Regression Results for Japan with Total Government Expenditure

Threshold variable: Total government expenditure (YPGT_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 54th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.343	[2] >0.343
Investment / GDP	0.149	-0.013	0.16
	[1.53]	[0.12]	[1.00]
Labor force growth	1.562***	1.826***	0.698***
	[5.79]	[4.16]	[2.95]
Gov exp growth x Gov exp / GDP	0.088	0.640***	-0.196*
	[0.63]	[3.05]	[1.77]
Constant	-0.013	0.012	-0.017
	[0.71]	[0.65]	[0.56]
R2	0.34	0.32	0.14
No. of obs	152	79	73

2nd threshold: 91st percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.343	[2] >0.343 & <=0.370	[3] >0.370
Investment / GDP	0.149	-0.013	-0.248	1.151*
	[1.53]	[0.12]	[1.44]	[1.89]
Labor force growth	1.562***	1.826***	-0.19	-0.459
	[5.79]	[4.16]	[0.75]	[0.46]
Gov exp growth x Gov exp / GDP	0.088	0.640***	-0.219	-0.199*
	[0.63]	[3.05]	[1.64]	[1.90]
Constant	-0.013	0.012	0.068**	-0.203*
	[0.71]	[0.65]	[2.11]	[1.83]
R2	0.34	0.32	0.13	0.11
No. of obs	152	79	41	32

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.5 (1) Regression Results for the United Kingdom with Government Consumption Expenditure

Threshold variable: Government consumption expenditure (CGV_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 98th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.268	[2] >0.268
Investment / GDP	0.106	-0.192*	0.224
	[0.90]	[1.93]	[0.17]
Labor force growth	0.563**	1.017***	-2.572***
	[2.28]	[3.95]	[4.85]
Gov consump growth x Gov consump / GDP	-0.429	-0.108	-0.191
	[1.03]	[0.24]	[0.27]
Constant	0.007	0.049***	-0.017
	[0.45]	[3.52]	[0.10]
R2	0.06	0.16	0.48
No. of obs	152	127	25

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.5 (2) Regression Results for the United Kingdom with Government Investment

Threshold variable: Government investment (IGV_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 29th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.014	[2] >0.014
Investment / GDP	0.088	0.595***	-0.287
	[0.69]	[3.47]	[1.45]
Labor force growth	0.549**	0.196	0.885**
	[2.21]	[0.74]	[2.32]
Gov inv growth x Gov inv / GDP	0.948	3.491***	1.088
	[1.43]	[3.55]	[1.21]
Constant	0.008	-0.057**	0.057**
	[0.45]	[2.31]	[2.09]
R2	0.07	0.35	0.09
No. of obs	150	53	97

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Table 2.6.5 (3) Regression Results for the United Kingdom with Total Government Expenditure

Threshold variable: Total government expenditure (YPGT_Y)
Dependent variable: Real GDP growth rates
Estimation method: OLS, robust

1st threshold: 78th percentile

Threshold value (the ratio to GDP)	Linear model	[1] <=0.454	[2] >0.454
Investment / GDP	0.105	-0.385***	0.609*
	[0.89]	[3.57]	[1.87]
Labor force growth	0.561**	1.563***	-0.042
	[2.34]	[5.08]	[0.12]
Gov exp growth x Gov exp / GDP	-0.255**	0.016	-0.667***
	[2.59]	[0.21]	[5.14]
Constant	0.009	0.077***	-0.057
	[0.55]	[5.17]	[1.36]
R2	0.1	0.3	0.25
No. of obs	152	105	47

Notes:
Numbers in brackets are the corresponding robust t statistics.
** significant at 10%; ** significant at 5%; *** significant at 1%*

Figure 2.2.1 Government Spending and Threshold Values: The United States

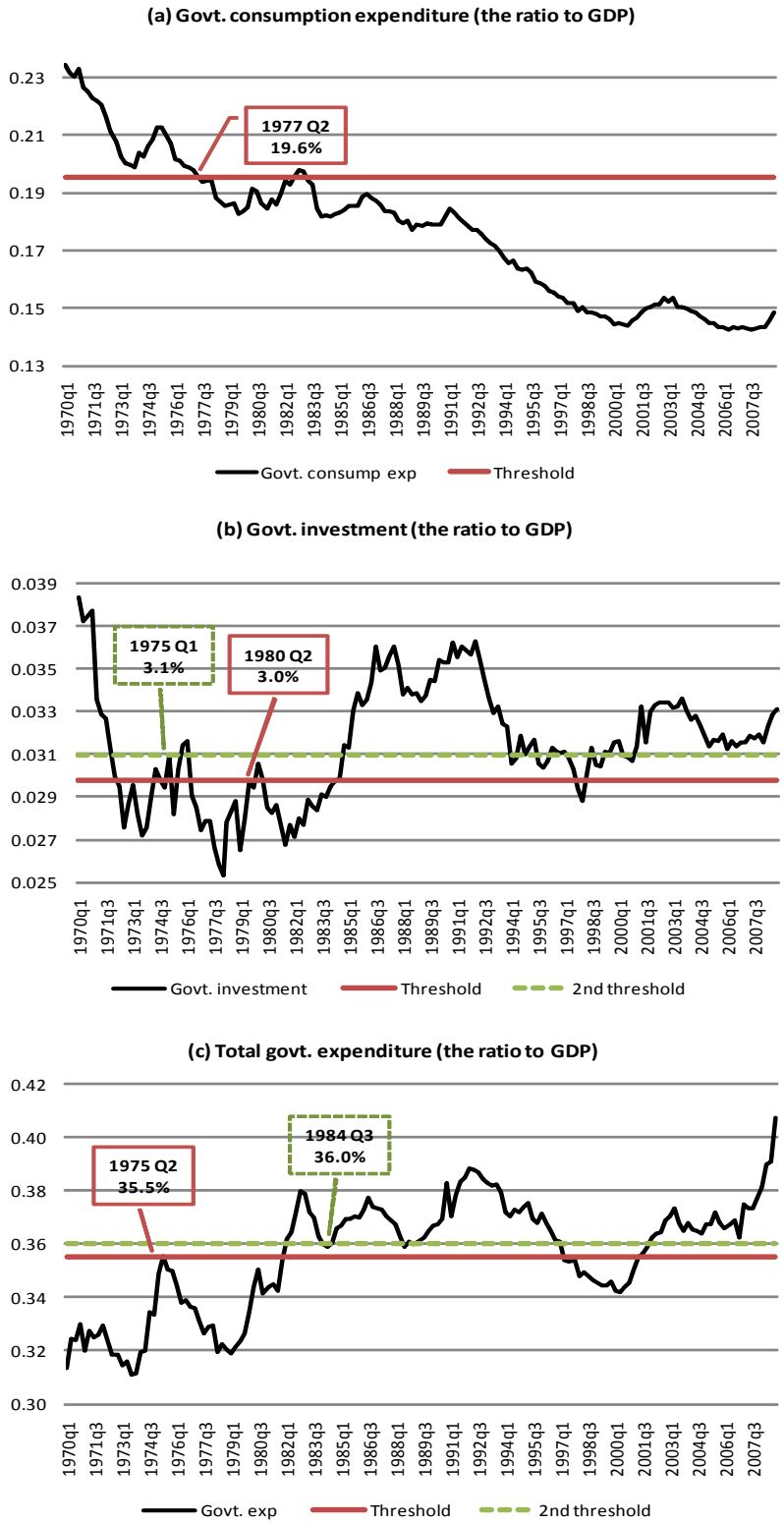


Figure 2.2.2 Government Spending and Threshold Values: Australia

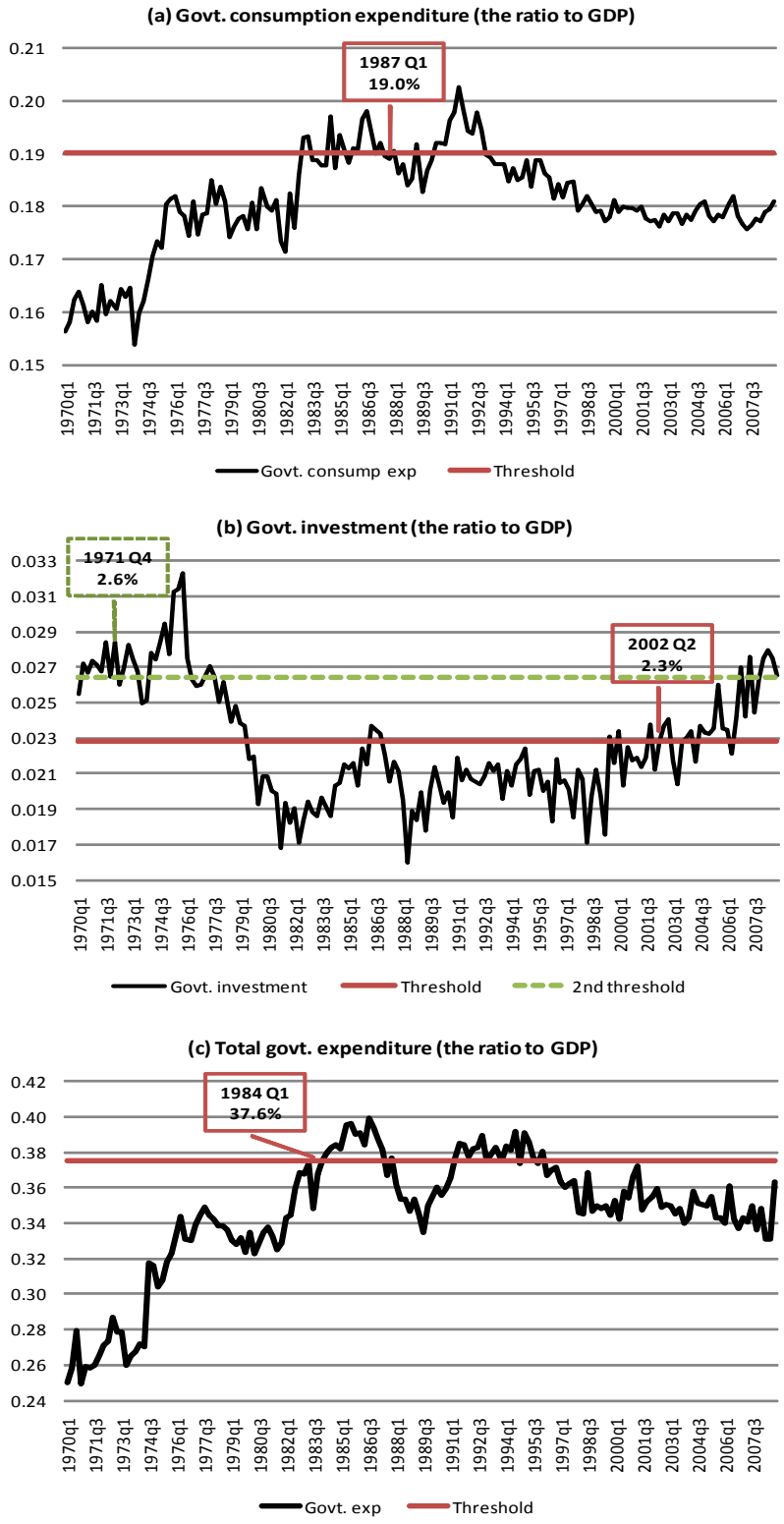


Figure 2.2.3 Government Spending and Threshold Values: Canada

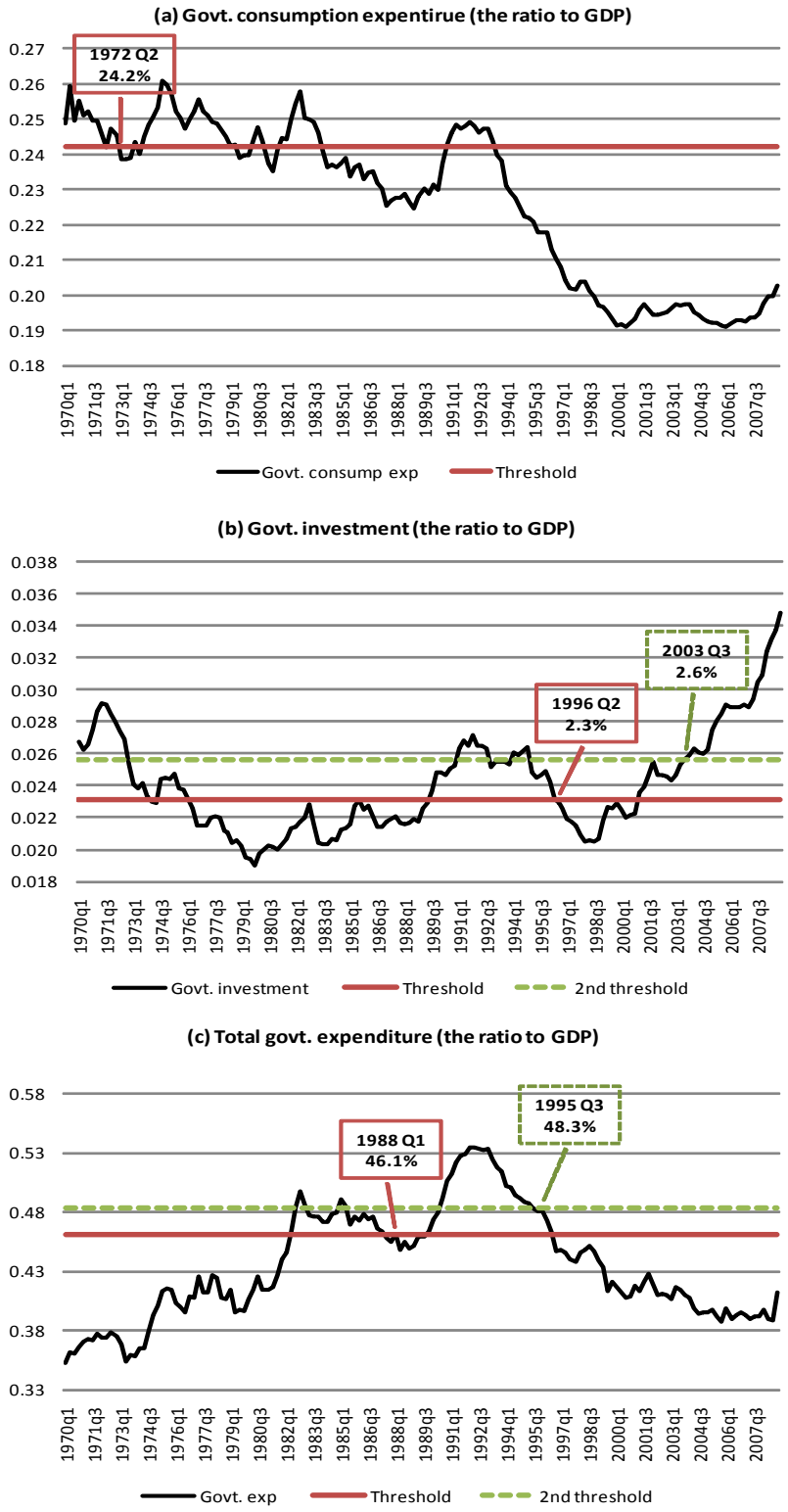


Figure 2.2.4 Government Spending and Threshold Values: Japan

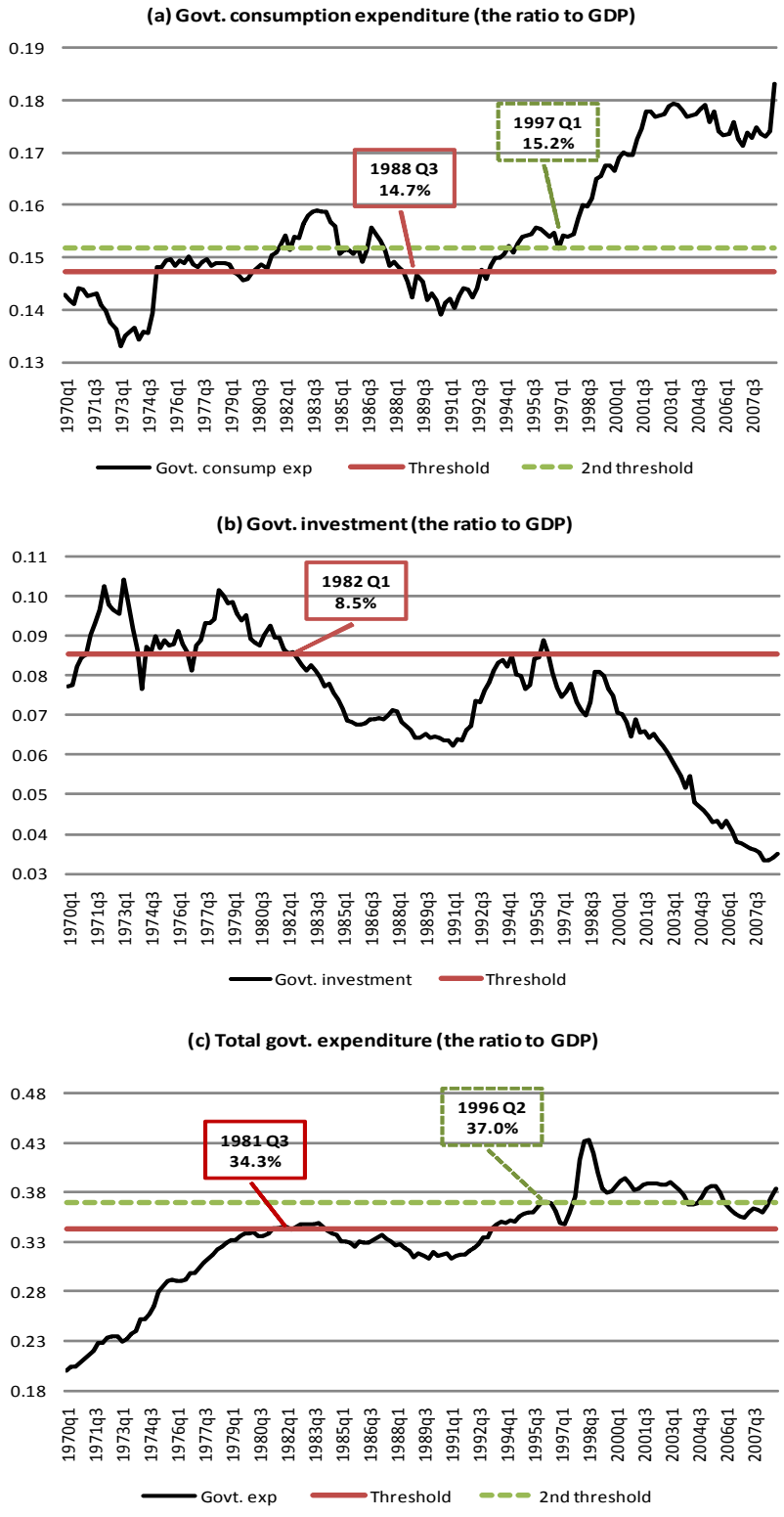
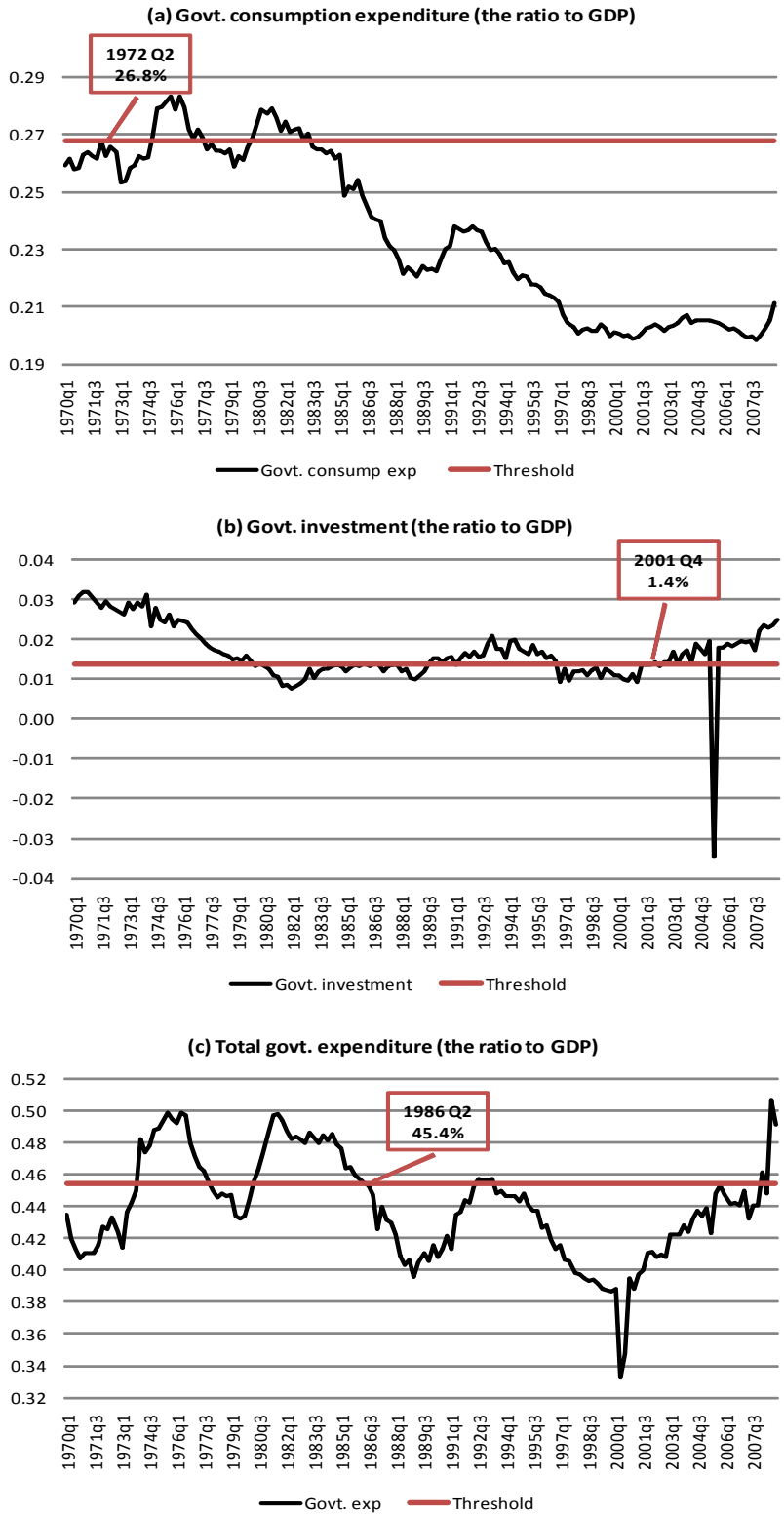


Figure 2.2.5 Government Spending and Threshold Values: The United Kingdom



Chapter 3: The Composition of Government Spending and the Short-Run and Long-Run Economic Performance

3.1 Introduction

There is a general perception that excessive government spending is harmful for long-run economic performance, while at the same time, it is generally accepted that expansionary government spending is favorable at business cycle frequencies. It is useful, therefore, to attempt to simultaneously estimate the "short-run" and "long-run" effects of fiscal policy on real economic performance.

Loayza and Ranciere (2006) use a pooled mean group (PMG) estimator introduced by Pesaran, Shin, and Smith (1999) to investigate the short-and long-run effects of financial deepening on growth, where the short-and long-run effects are estimated jointly by a general autoregressive distributed-lag (ARDL) model. This paper adopts their approach to investigate the impacts of fiscal policy (represented by the components of government spending relative to GDP) on economic activity at both economic growth and business cycle frequencies for Latin American, East Asian, and European countries where the patterns of economic performance have been quite different over the last 30 years. The paper further explores the relationship between fiscal policy and economic performance through alternative channels: it takes into account the composition of government spending and looks at the separate effects of infrastructure spending and social spending.

The main findings of the paper are the following. First, government spending on infrastructure such as transport and communications as well as energy has positive short-run impacts on real macroeconomic performance. The long-run relation of energy

spending to growth is also positive, while that of transport and communications spending is negative and statistically significant. This result is in contrast to a series of theoretical and empirical studies which predicted the positive impacts of infrastructure spending on economic growth, but is in line with the finding of Devarajan et al. (1996). Devarajan et al. explained the negative impacts of government capital expenditure on growth might be caused by the excessive use of government capital expenditure. In other words, capital expenditure which is normally considered growth enhancing, could become unproductive if it is used excessively and inefficiently. The negative effect of transport and communications spending might also indicate that the level of government spending is above the optimal value so that government spending no longer contributes to macroeconomic performance but it rather adversely affects the economic activity.

Second, government spending on social services such as education and health has a positive long-run relationship with growth. The results are statistically significant and economically important. However, the short-run impacts of education spending on growth are negative. The result might be interpreted that the returns on government spending on human capital will become measureable only in the long-run. In the short-run, spending on human capital will take away the resources that can be used for other productive expenditures. Moreover, health spending appears to have positive effects to growth in both the short-and long-runs only when an increase in the share of health spending is adjusted by a decrease in other spending shares, while keeping total government expenditure remains constant. This finding is consistent with Furceri (2009) who found the strong stabilizing role of social spending to smooth output shocks.

Finally, increasing government's consumption expenditures, which are usually considered unproductive spending, has negative impacts on long-run economic performance. The short-run impacts of higher government consumption expenditures are also found to be negative.

The overall empirical results suggest that there is evidence that expansionary fiscal policy on government spending on infrastructure and health is favorable to growth at business cycle frequencies, but it does not necessarily mean that it spurs the long-run economic performance as well. In addition, government spending on human capital seems to start generating positive returns to growth only in the long-run.

One of the main contributions of the paper is the identification of the impacts of various components of government spending on economic growth. In addition, it attempts to address both the short-and long-run effects of these components simultaneously. This is a useful contribution because given limited government resources, it is critical to understand which components of government spending promote growth at different time horizons and adjust resources towards more productive and efficient areas.

Another contribution of the paper is an implication on the fiscal space issue. Changes in fiscal policy (either cuts or increases in certain expenditures) are always politically challenging. There has been discussion about creating "fiscal space" carried on international development organizations such as the World Bank, IMF, and bilateral

donor community in recent years[1]. One way for a government to create fiscal space is to re-prioritizing expenditure, that is, reduce unproductive expenditures in order to make room for more productive ones, which includes creating fiscal space for government spending on infrastructure, education, and health which is likely to pay for themselves over the medium and long-term.

The rest of the paper is structured as follows. Section 2 provides a literature review. Section 3 presents data description and sources. Section 4 introduces econometric methodology and the model. The estimation results are discussed in Section 5. Section 6 is conclusion.

3.2 Literature Review

The role of fiscal policy can be aimed for a short-run macroeconomic stabilization and enhancing long-term growth. Discretionary fiscal policy measures taken in response to the current crisis (i.e. stimulus packages) have a large variation in size across countries. The stimulus effects of fiscal packages also vary across policy instruments and countries. It has been considered that the size of discretionary fiscal package varies inversely with the size of automatic stabilizers among industrial countries. In other words, countries with a small automatic stabilizer such as the United States and Japan need to implement large size of stimulus packages. Moreover, the stimulus packages differ across countries by composition; either cutting taxes or increasing spending (OECD, 2009).

[1] "The fiscal space can be defined as the availability of budgetary room that allows a government to provide resources for a desired purpose without any prejudice to the sustainability of a government's financial position" (Heller, 2005).

Thus, changes in fiscal policy will affect the composition of government spending and the country's growth path in both the short-and long runs. In fact, the composition of spending differs substantially across countries or regions, and also changes over time. One of the major factors that affect the composition of government spending is fiscal adjustments.

A number of studies suggest that fiscal adjustments associated with declines in spending are less contractionary compared to tax-based adjustments such as tax hikes, mainly because the former typically benefits from a large dose of monetary stimulus, as well as an expansion in exports (Leigh et al., 2010). Using a new measure of fiscal shocks, Romer and Romer (2010) find the evidence that supports the strongly significant impact of tax changes on real output[2]. In addition, the effects of fiscal adjustments differ across different types of spending cuts. Spending cuts to politically sensitive items such as transfer programs, government consumption, and the public sector wage bills have more benign contractionary effect to output and investment as cutting politically sensitive items usually signals a credible commitment to long-term deficit reduction. On the other hands, cuts to less politically sensitive items such as government investment, might show a lack of confidence in the government on decreasing deficits and thereby its contractionary impact is larger (Leigh et al., 2010).

Segura-Ubiergo et al. (2010) investigate the impacts of fiscal adjustments[3] on growth in transition economies by using a fixed-effects panel data error-correction model.

[2] Their estimates show that the tax increase of 1 percent of GDP will reduce output over the next three years by nearly three percents.

[3] Fiscal adjustment is measured by the percentage of general government overall fiscal balance to GDP.

They find the positive effect on growth in both the short-and long-runs, and that its magnitude is not qualitatively very different from what has been observed in industrial countries. They also claim that change in the composition of government spending as a result of fiscal adjustments appears to affect growth rates in these countries.

As for the theoretical literature on the impact of fiscal policy on growth, endogenous growth models allow permanent growth effects of fiscal policy and differentiate between productive and unproductive government spending (i.e. Barro, 1990, 1991, and Sala-I-Martin, 1992)[4]. Productive spending includes public investment such as public infrastructure and human capital spending which raises growth, while unproductive spending contains government consumption expenditures which deters growth in an excessive level[5]. Following earlier theoretical framework, Devarajan et al. (1996) use the model with two types of government expenditure: productive and unproductive, and how the change in the ratio between the two influences the economy's growth rates in the long-run.

A series of empirical literature on fiscal policy and growth confirm the findings of earlier theoretical study by claiming that certain government expenditures have more positive effects on economic growth than others. A number of studies focus on the differential effects of productive (capital) and non-productive (current) components of public spending on growth.

[4] Neoclassical growth models treat all government spending as productive and allow only a transitional effect on growth rates. Arrow and Kurz (1970) assume that public capital, rather than the flow of public services enters into the production function.

[5] Education is considered as public investment rather than public consumption, as it tends to raise private-sector productivity or property rights.

Many claim a positive correlation of infrastructure investment on economic growth (Easterly and Rebelo, 1993, Aschauer, 1989, Canning and Fay, 1993). In particular, public investment in transport and communications seems to have gained high returns in the long-run (Easterly and Rebelo, 1993, Kocherlakota and Yi, 1996[6]).

In contrast, Devarajan et al. (1996) find that current expenditures have positive and significant effects on growth by using a panel of data from 43 developing countries for 1970-1990, while the capital components of public expenditures such as transport and communications have negative impacts on per-capita growth. The intuition behind the result is that the excessive use of capital expenditures could turn normally productive investment such as infrastructure investment into unproductive. This is often observed in developing countries with low institutional quality such as high level of corruption and inefficient financial system.

These contrasting findings might be explained by the level of efficiency in terms of government spending as well as the level of development in a country. Estache et al. (2007) investigate the efficiency of government expenditures at the sectoral level (education, health, and infrastructure) across countries for the period 1990 through 2002. Their study shows that the level of efficiency in general has improved during the 1990s in the energy and education sectors but has not improved significantly in the transport sector.

In addition, a number of empirical studies investigated the impacts of current expenditures which considered unproductive on economic performance. A negative long-run relationship between the growth rate of GDP and government size is the standard result

[6] Kocherlakota and Yi (1996) provide evidence in an industrial country. US capital expenditures such as government non-military capital investment (i.e. highways and streets) have a statistically positive effect on long-run GNP levels on time-series US data from 1917-88.

from the empirical growth literature[7]. Loayza and Ranciere (2006) show that the size of government measured by government consumption expenditure is negatively related to the growth rate of GDP per capita both in the short-and long-runs.

The role of social spending as a stabilization tool is also discussed in some studies. Furceri (2009) assesses the role of social spending to smooth output shocks and to provide stabilization. His study finds that government spending in social services, in particular spending devoted to unemployment and old age has a more stabilizing effect than total government spending as a whole. In fact, overall social spending is able to smooth about 16 percent of a shock to GDP. Moreover, the stabilization effects of social spending are significantly larger in those countries where the size of social spending is larger.

Social spending has become more favor in many countries rather than infrastructure. Pattillo et al. (2005) report that even in low and middle income countries[8], government spending has become more in favor of social spending (i.e. social security, education, and health care), and less so on infrastructure spending. Kaufman et al. (2001) find that there is evidence that Latin American countries with more integration to international markets hold less fiscal commitments to social spending, which is not influenced by political factors.

3.3. Data Description

This section discusses the important aspects of data set used in the paper such as sample selection criteria and sources.

[7] Barth and Bradley (1987) found a negative relationship between the growth rate of real GDP and the share of government consumption spending for 16 OECD countries in the period 1971-93.
[8] Pattillo et al. (2005) focus on fast growing Sub-Saharan-African countries.

3.3.1. Country Selection

Most empirical studies that investigated a relationship between the composition of government spending and economic growth used a large sample of cross-country dataset including both developing and industrial countries. In those studies, many countries, in particular developing countries have limited availability of data on disaggregated government spending. Some studies have overcome this shortcoming by averaging the data by income level such as low-, lower-middle, and upper-middle income group countries[9], while others have used intervals (i.e. taking five year average for each spending)[10].

This paper does not follow the aggregation approach. Rather than using a broad cross-section of countries where the functional spending data are aggregated, this paper makes use of detailed time-series data collected for a set of countries with better data quality. The set includes countries from Latin America, East Asia, and Europe for the period 1970 - 2006 with annual frequency. In the Latin American region, Caribbean countries[11] as well as small countries such as Nicaragua, Paraguay, and Uruguay are excluded. The European region only includes industrial countries[12]. The sample from each region consists of six to nine countries and the countries' selection is based on the data availability of functional government expenditures. The list of countries in each region is shown in Table 3.1, and the time coverage of fiscal data for the data set used in the analysis is reported in Table 3.2, respectively.

[9] The World Bank Interim Report (2006).

[10] Easterly and Rebelo (1993) use the average over the 1970-88 periods.

[11] Caribbean countries include Dominican Republic, Jamaica, and Trinidad and Tobago.

[12] All countries included in European region are EU15 members.

3.3.2 Data Sources

The main data source for fiscal data is the Government Financial Statistics (GFS) database from the IMF. The GFS database is only source which collects internationally comparable disaggregated government spending data. Although it is optimal to obtain government spending data from the general government account which consists of national and sub-national government accounts, the GFS database has severely limited data coverage at the general government level[13]. Thereby, an original data collection effort was made and the data used in this paper includes government spending at both central and subnational government levels[14]. The level of financial decentralization for each country is used to determine whether only consolidated-central government or both consolidated-central and subnational government data are included for analysis. How the level of financial decentralization is determined is explained later in this section.

In other words, the GFS database has a good coverage of fiscal data at the central government level, but moderate at the sub-national government level (state and local governments). In order to fill the missing observations at the subnational level, various sources are used, including the United Nations regional agencies, government statistical agencies, and the World Bank publications. All the data sources are explained in Appendix 3.1.

The availability of various levels of government spending by sector and country is shown in Table 3.3. In addition, Table 3.4 provides the data availability of countries

[13] Data at the general government level are available only from the late 1990 onwards and for few countries.

[14] It is claimed that the difference between central and general government aggregates is small for most low and lower-middle income countries (The World Bank, 2006).

excluded from the sample, indicating which variables cause which countries to be eliminated from the final data set.

3.3.3 Components and Structure of Government Spending

3.3.3 (a) Composition of Government Spending

The data collection has focused on four core functional government spending series: transport and communications, energy, education, and health. The first two variables are the proxy for infrastructure spending and the last two represent social spending. In addition to these functional expenditures, data were also collected on general government final consumption expenditure[15], which is often used as a measure of the size of government[16]. These four government spending variables contain both current and capital expenditures[17], while general government final consumption expenditure only includes current expenditure. Figure 3.1 shows the time path of government spending series for the whole sample and by region.

3.3.3 (b) The Structure of Public Sector and Government Spending

The structure of the public sector is presented in Figure 3.2. The GFS database excludes the expenditures of public corporations, while it includes transfers from the central government to both local government and public enterprises. Figure 3.3 provides

[15] The definition of general government final consumption expenditure includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditure on national defense and security, but excludes government military expenditures that are part of government capital formation.

[16] Barro (1991) claims that general government final consumption expenditure is served as a proxy for taxes collected and then dissipated unproductively.

[17] These government expenditures are categorized as functional expenses, where the sum of function expenses is total outlay. On the other hand, total expenses (or total expenditures) are the sum of economic classification (compensation, subsidies, grants, social benefits, etc).

the structure of government spending, that is, the schematic breakdown of the components of government spending, and how the components of government spending are classified. Total expenditure consists of both current and capital expenditures, of which is classified into functional expenditures including economic affairs (such as fuel and energy, and transport and communications), education, health, etc. The functional expenditures contain both the acquisitions of assets for the function as well as expense (that is, current and capital expenditures), but the disaggregation of current and capital expenditures for each functional expenditure is not available.

3.3.4 The Level of Fiscal Decentralization

As mentioned earlier, it is preferred to obtain the four functional government expenditures from the general government accounts which consist of national and sub-national government accounts[18]. However, expenditures at the general government level are neither always available nor reported in the GFS database (as shown in Table 3.3). When they are not available, the expenditures series used in the study may not allow capturing the full impact of public expenditures on economic growth. This paper tried to mitigate this shortcoming by gathering both central[19] and subnational government

[18] The general government sector can be divided into central, state, and local government sub-sectors. Not all countries will have all three levels of government; some may have only a central government or a central government and one lower level (GFS manual).

[19] Consolidated-central government account is used. Consolidated central government sector includes budgetary and extra budgetary accounts as well as social security funds.

expenditures and treating either only central government expenditure or the sum of central and subnational expenditures as an equivalent to those at the general government level[20].

Whether only central government or both central and subnational government data are used for analysis is determined by the level of fiscal decentralization for each country. The key idea is that if a country has a high level of fiscal decentralization, then it is more reasonable to treat the sum of central and subnational government expenditures as total expenditure. Or, if a country has a highly centralized system, then it might be more reasonable to treat the expenditure at central government as total expenditure. Thus, I constructed the decentralization index which determines the level of fiscal decentralization for each country. Using the index, for countries with a high degree of fiscal decentralization I used both central and subnational (either state or local or both) levels of government expenditures whereas for those countries that are highly centralized I only used the central government expenditures. The index was created and used in order to obtain comparable levels of fiscal data coverage across the countries in the sample. Therefore, if a country was known as highly decentralized but fiscal data was available only at the central government level but not at subnatinal government levels, then the country was dropped from the analysis.

To create the index, I used the following two measures which are often used to determine the level of fiscal decentralization: one is the share of subnational spending to national expenditure, which can be used to compare the level of decentralization across

[20] It is claimed that the difference between central and general government aggregates is small for most low and lower-middle income countries (The World Bank, 2006).

countries, and another the pattern of responsibility for expenditures assigned among different levels of government.

A series of studies confirm that there exist large regional differences in terms of the level and pattern of fiscal decentralization. East Asia has been recognized to have one of the most centralized public expenditure systems[21], while in Latin America decentralization is more visible and is considered to have caused critical fiscal imbalances to some countries[22]. European countries included in the paper are all industrial countries and are members of EU15. The level of fiscal decentralization in industrial European economies as well as OECD countries has been increasing during the last three decades (Darby et al., 2003, Stegarescu, 2005)[23].

As for the second measure of fiscal decentralization, both education and health are commonly handled by local governments in many countries. The second measure, however, identifies only which level of government provides the services, not necessarily the one that finances the services. Indonesia and Thailand are quite decentralized compared with other East Asian countries, with education and health assigned solely to local governments[24]. In the Philippines, health is a joint responsibility of the state and local governments, while education remains a central government responsibility. Bankauskaite

[21] In terms of the subnational share of total national expenditure, Vietnam was decentralized to the extent of 48 percent, while Thailand with only 10 percent. Philippines and Indonesia are somewhere in the middle with 26 and 32 percent (after Big-Bang decentralization), respectively.

[22] Brazil and Argentina are often known as the best examples. Recent administrations in Bolivia, Colombia, and Venezuela granted regional local governments substantial resources and responsibilities (Smoke, Part IV, 2006).

[23] Darby et al. (2003) show the share of subnational expenditure to total general government expenditure by functions over time, and they find that the patterns quite defer depending whether the country is unitary (i.e. Switzerland) or federal country (i.e. Denmark, Norway, and the United Kingdom).

[24] Although Indonesia assigns education and health to subnational levels, subnational governments finance the services through specific transfers from the central government.

et al. (2007) report that predominantly tax funded countries in Europe, raising health care funds is mainly responsible of different levels of government[25].

3.3.5 Variables Used in the Regressions

In the regression analysis, which is explained in Sections 4 and 5 below, the dependent variable is the growth rate in real GDP per capita. The main explanatory variables are the components of government spending including transport and communications, energy, education, and health as well as total expenditure as percentage share of GDP. These functional expenditures consist of both current and capital expenditures. In addition, general government final consumption expenditure as percentage of GDP, which contains only current expenditure,[26] is used as a proxy of government size. A number of previous studies have found a significant negative relationship between government size and the growth rate in real GDP per capita[27]. The set of control variables that are considered to consist of cross-country variation in growth[28] are the following: the initial level of real GDP per capita, total investment as share of GDP, and inflation. All the expenditure and control variables are transformed in natural logs.

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[25] There are two types of tax-funded health care systems, one is the systems in which subnational levels of government have a right to raise tax and spend funds (i.e. Denmark, Finland, and Sweden), and another the systems in which subnational levels of government predominantly receive grants from the central government (i.e. Spain and the United Kingdom).

[26] The general government final consumption expenditure includes all government current expenditures for purchases of goods and services (including compensation to employees). It also includes most expenditure on national defense and security, but excludes government military expenditures that are part of government capital formation.

[27] Government consumption lowers economic growth as the higher taxes needed to finance the consumption expenditure reduces returns on investments and the incentive to invest.

[28] Levine and Renelt (1992), Sala-i-Martin et al. (2004), and other literature.

The dependent and country specific control variables are mainly collected from the WDI database from The World Bank, Penn World Table 6.2, and the dataset from Loayza and Ranciere (2006). All the definitions and data sources of variables used in the regression analysis are given in Table 3.5. Table 3.6 reports descriptive statistics of main variables for the whole sample and by region, and Table 3.7 presents the correlation table of variables, respectively. As shown in Table 3.2, the dataset used in the paper is unbalanced, and there are more numbers of observations available for aggregated variable such as general government final consumption expenditure than the four components of government spending. In addition, some functional expenditures had missing observations. Those missing observations were filled by either interpolating or using other data sources. The final dataset has no gap and longer time dimension.

3.4 Econometric Methodology

Using a panel of cross-country and time-series observations for a sample of countries from 1970-2006, the paper estimates both the short-and long-run effects of government spending on growth thorough the PMG estimator, introduced by Pesaran, Shin and Smith (1999). This section introduces the main characteristics of the PMG estimator and compares it with alternative estimators of nonstationary heterogeneous panels.

Pesaran et al. (1999) introduced a methodology to estimate nonstatonary dynamic panels where the parameters differ across groups. The PMG estimator assumes that the long-run coefficients are common across countries, but allows the short-run (error-correction) coefficients to vary from country to country. That is, this estimator allows the

intercepts, short-run coefficients, and error variances to differ across groups, but constrains the long-run coefficients to be the same.

Their methodology deviates from traditional cointegration method in several points. First, although traditional cointegration literature claims that long-run relationships exist only among integrated I(1) variables, Pesaran et al. (1999) argues that their methodology can provide consistent and efficient estimates of the parameters in a long-run relationship between both nonstationary (or integrated) I(1) and stationary I(0) variables. In other words, as long as regressors are autoregressive, a long-run relationship can exists between a stationary I(0) dependent variable and the regressors irrespective of whether the regressors are I(1) or I(0).

Second, their methodology does not require formal tests such as unit root and cointegration tests to prove that there is a cointegrating relationship among variables included in regressions as long as the following two assumptions are satisfied: one is that the variables of interests have a long-run relationship[29] (which also means that the error-correction term is strongly negative but no less than -2), and another that the regressors are strictly exogenous and the residuals are serially uncorrelated. The second assumption can be satisfied by augmenting the lag order of the dynamic regression equation. Such a model is called an autoregressive distributed lag (ARDL) model.

In the paper, a pooled ARDL error-correction model is estimated by the PMG estimator. The use of this specific model has several advantages to address the diversity of fiscal policy approaches across countries. First, using the pooled error-correction model

[29] Pesaran et al. (1999) recommended to conduct a panel test for the existence of a long-run relationship when the variables are I(1), which is similar to the panel unit root test suggested by Im et al. (1997).

allows analyzing both the cross-country differences and changes within individual countries over time.

Second, the PMG estimator splits the short-run and long-run effects. As mentioned earlier, the PMG estimator allows short-run country specific heterogeneity but constraints the long-run coefficients to be same across countries. This feature of the PMG estimator is useful to estimate the impact of changes in government spending on economic growth as fiscal policy differs across countries in terms of the size and its execution. For instance, certain government policies such as fiscal adjustment and stimulus packages affect the composition of government spending. The change in the composition varies across countries depending on the country's political and financial systems, which affects the country's growth path in the short-run. In contrast, long-run relationships tend to be more homogeneous across countries as the long-run impact of certain government expenditure on economic growth will be similar. In other words, infrastructure and social spending have a tendency to have a positive impact on economic activity in the medium and long-run.

Using the panel error-correction method has some advantages compared to the traditional method of time-averaging the data per country, which is used for traditional growth regressions. First, averaging the data with fixed length intervals, which is applied to eliminate business-cycle fluctuations, causes loss of important information, and its effectiveness is not clear. Second, averaging does not allow for some heterogeneity of

parameters across countries to be estimated. Lastly, averaging hides the dynamic relationship between changes in government expenditures and growth[30].

The model is estimated for the entire group of countries, but not for each subset. Estimating the model for each subset of countries was avoided due to a small number of sample countries in each region.

3.4.1 Estimation Model

An autoregressive distributed lag (ARDL) $(p, q_1, \cdots, q_k)$ dynamic panel specification of the model is given as follows:

$$(1)\ y_{i,t} = \sum_{j=1}^{\rho} \gamma_j^i y_{i,t-j} + \sum_{j=0}^{q} \delta_j^i X_{i,t-j} + \varepsilon_{i,t}$$

where the number of countries i=1,2,….,N; and the number of years t=1,2,…,T; $y_{i,t}$ is the real per capita GDP growth rates for country i at time t; $X_{i,t}$ is a set of control variables ($k \times 1$vector) for country i at time t including government spending, initial GDP per capita, investment, and inflation, and $\varepsilon_{i,t}$ is a time-varying disturbance. I furthermore assume that the variables in Eq. (1) are I(1) and conintegrated, and therefore the error term $\varepsilon_{i,t}$ is an I(0) process for all i.

[30] For the detailed discussion, see Loayza and Ranciere (2006).

Re-parameterizing Eq. (1) into the panel error-correction model (ECM), the specification of the panel ECM is as follows:

$$(2)\ \Delta y_{i,t} = \sum_{j=1}^{p-1} \gamma_{ij}^{*} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}^{*} \Delta X_{i,t-j} + \phi_i [(y_{i,t-1} - \{\beta_0 + \beta_i' X_{i,t-1}\}] + \varepsilon_{i,t}$$

$$\text{where } \phi_i = -\left(1 - \sum_{j=1}^{p} \gamma_{ij}\right),\ \beta_i = \sum_{j=0}^{q} \delta_{ij} / \left(1 - \sum_{k} \gamma_{ik}\right),$$

$$\gamma_{ij}^{*} = -\sum_{m=j+1}^{p} \gamma_{im}\ ,\ j = 1,2,..., p-1; \text{ and } \delta_{ij}^{*} = -\sum_{m=j+1}^{q} \delta_{im}\ ,\ j = 1,2,..., q-1;$$

Δ is the first differences operator, γ^{*} and δ^{*} are the short-run coefficients related to growth and its determinants, β is the long-run coefficients, and ϕ is the speed of adjustment to the long-term relationship. The term in the square brackets in Eq. (2) contains the long-run growth regression, which indicates the presence of a long-run relationship between $y_{i,t}$ and $X_{i,t}$:

$$(3)\ y_{i,t} = \beta_0^{i} + \beta_1^{i} X_{i,t-1} + \mu_{i,t}$$

where $\mu_{i,t}$ ~ I(0). In addition, the paper examines how the composition of government spending affects economic performance. For example, the hypothesis that government spending on infrastructure has a differential impact on economic growth than government

spending on social services is tested. The parameter ϕ is expected to be significantly negative and no less than -2 under the assumption that the variables return to a long-run equilibrium. The variable (and vector) β_1^i indicates a long-run relationship between the real per capita GDP growth rates and government spending as well as other control variables. As Eq. (2) is nonlinear in the parameters, Pesaran et al. (1999) develop a maximum likelihood method to estimate the parameters.

3.4.2 Two Model Specifications

In the paper, Eq. (2) is estimated with two model specifications. The first model specification contains four functional government spending variables (transport and communications, energy, education, and heath) in the percentage of GDP. The second model specification includes the same four spending variables as the percentage of total expenditure and total expenditure as the percentage of GDP.

In the former used in Easterly and Rebelo (1993), fiscal variables are shown in GDP which mixes the level effects of spending with the composition effect. In this model, a unit increase in the share of spending in GDP does not necessarily mean that other expenditure items are decreasing.

On the other hand, the latter follows Devarajan et al. (1996) who tested whether the share allocated to different components of government spending is associated with higher growth. The share of total government expenditure in GDP (in percentage) is included to control for level effects. This is to control for the effects of financing government expenditure. In other words, a unit increase in the budgetary share of one

spending (i.e. education) has to be adjusted by a unit decrease in some other spending share(s), keeping the size of total spending remains fixed.

3.4.3 Choosing the Optimal Lag Length

As mentioned earlier, for the model to satisfy the assumptions, the equation needs to be augmented sufficiently[31]. To determine the appropriate lag structure of the ARDL, some consistent information criteria such as Schwartz-Bayesian Criterion (SBC) can be used on a country-country basis. However, it is also critical to use a common lag structure across countries so that short-run coefficients are comparable across countries.

In order to determine the optimal lag length of dependent and government spending variables, a simple linear regression model was estimated using the panel dataset. The maximum of three lags for both dependent and government spending variables, and one lag of each control variable were tested. Based on the SBC, it turned out that the best lag length is ARDL(1,2) and the second best is ARDL(1,1). Time dimension of four functional government spending data tends to be shorter compared to that of general government consumption expenditure and total expenditure and varies across countries as well as sectors. Thereby, estimating the model with more than one lag of spending variables often did not run or converge. Because of the reason, the common lag structure of the model with one lag of the dependent, government spending, and control variables was selected.

[31] I assume that all the variables in the equations (1) are I(1) and cointegrated, making disturbance term $\varepsilon_{i,t}$ an I(0) process for all i.

Pesaran et al. (1999) claims that when the panel is very unbalanced and time dimension is small for some observations, choosing lag order by the SBC is more reliable than using a common ARDL (1,1) which tends to show misspecification. They also show that the estimates of the long-run coefficients are robust to the order of the ARDL when time dimension is large. When the time dimension is small, the choice of lag order whether either two or three lags is used becomes more important. In addition, they claim that the PMG estimator is more robust to outliers and to the choice of lag order. The dataset used in the paper has the time dimension from 1970 through 2006 which is long enough. Thereby, I believe the estimation results should not be affected much by using either one lag or two lags of the variables.

3.4.4 Alternative Heterogeneous Panel Estimators

When both the time-series and cross-sectional dimensions of the panels are relatively large, there are several approaches to estimate Eq. (2). Following Pesaran et al. (1999), in this section, I introduce alternative two dynamic panel data estimators: the mean group (MG) and dynamic fixed effects (DFE) estimators, and compare them with the PMG estimator in terms of consistency and efficiency.

First, proposed by Pesaran and Smith (1995, 1997), the MG estimator estimates the model separately for each group, and takes a simple average of the coefficients. In other words, this estimator produces the intercepts, slope coefficients, and error variances which are all different across groups. The MG estimator provides consistent estimates of the mean of the long-run coefficients, and these estimates will be inefficient if the slope is

identical across groups.

Second, the dynamic fixed-effects (DFE) estimation approach pools the time-series data for each group and thereby restricts all slope coefficients across groups to be equal and only allows the intercepts to differ. If the slope coefficients are not identical, then the DFE approach produces inconsistent and misleading results.

Finally, the PMG estimator, as explained earlier, combines both pooling and averaging the coefficients, allowing the intercept, short-run slope coefficients, and error-variances to differ across groups, but constraining the long-run coefficients to be identical across groups.

If the long-run slope homogeneity is true, the estimators imposing cross-country constraints on the long-run slope coefficients (i.e. pooled estimators such as the PMG or DFE estimators) are consistent and efficient. If the slope homogeneity does not hold, then the restricted estimators are inconsistent. In particular, imposing invalid parameter homogeneity in dynamic models typically leads to downward-biased estimates of the speed of adjustment (Robertnson and Symons, 1992, Pesaran and Smith, 1995).

In the next section, I discuss the estimated results using the PMG estimator and compare them with those using the MG and DFE estimators. In addition, Hausman test is applied to examine the difference between the MG and PMG estimators[32].

[32] The PMG and DFE estimators are restricted versions of the set of individual group equations.

3.5 Estimation Results

Table 3.8 shows the estimated results including the long-and short-run parameters of the components of government spending and other determinants on the real per capita GDP growth. Columns [1] through [4] report the estimated coefficients for the pooled error-correction model and their standard errors including the four components of government spending: transport and communications, energy, education, and health, respectively. An ARDL model includes one lag for the dependent and expenditure variables and each of control variables. The country specific results showing the short-run coefficients are reported in Tables 3.9.1 through 3.9.4. The results are also compared to those obtained by other estimators: the MG and DFE estimators, which are shown in Tables 3.10.1 through 3.10.3.

As explained earlier, two major model specifications are used to see if the results are robust across specifications. The first model specification (the results are shown in Table 3.8 columns [1] through [3]) uses government spending variables as a ratio to GDP (in percentage) which combines the level and composition effects of spending. In this case, a unit increase in the share of spending to GDP does not necessarily mean that other spending items are decreasing. In addition to the four government spending variables, the specification includes (in column [2]) general government consumption expenditure as a percentage ratio to GDP. Moreover, it includes (in column [3]) the percentage share of total government expenditure to GDP. On the other hand, the second model specification (the results are given in column [4]), uses the government spending variables as a share of total government expenditure (in percentage) and also includes the share of total

government expenditure to GDP (in percentage) to control for the level effects. In this case, a unit increase in the share of one spending has to be matched by a unit decrease in some other spending shares.

The model specification in column [1] does not include a variable to control for the level effects. When the overall size of government is not controlled, neither the long-run coefficients of spending variables nor the error-correction term are statistically significant, which suggests that there is no long-run relationship between the components of government spending and real GDP growth per capita.

In column [2], once the government size is included as a control variable, the long-run relationship between the components of government spending and economic growth becomes statistically significant for most cases. Moreover, the estimate of the error-correction term is significantly negative and no less than -2, which indicates that the variable does not have a unit root. The results show that government spending on transport and communications has a strong negative relationship with economic growth in the long-run, while its short-run relationship is positive. In contrast, the long-run relationship of energy spending with growth is positive while the short-run relationship is negative, but neither estimate is statistically significant.

In addition, the long-run positive impacts of education spending on economic growth coexist with the short-run negative effects. On the contrary, the long-run impacts of health spending are negative, but the short-run effects are positive. The effects of both education and health spending on growth are economically significant. Finally, as predicted by a series of empirical studies, increasing the size of government is negatively

related to long-term economic performance. The short-run relationship appears to be strongly negative as well.

The results shown in column [3] are quite similar with what have been found in column [2]. That is, the results for government spending on transport and communications as well as education still hold. In contrast to the results in column [2], government spending on both energy and health has positive impacts on growth in the long-and short-runs, and the impacts are statistically significant.

It is also worth mentioning that the results in column [3] are exactly the same as those in column [4] except for the coefficients of total expenditure and intercept. This indicates that including total expenditure variable in addition to the government spending variables (as percentage of GDP) serves as controlling for the level effects while keeping the size of total spending fixed as column [4]. Thereby, the results in both columns [3] and [4] can be interpreted such that an increase in a component of government spending has to be matched with a decrease in other spending.

To conclude, the results show that the short-run effect of infrastructure spending (both transport and communications, and energy) on economic growth is positive and its impact is statistically significant. However, its long-run effect differs across the components of infrastructure spending. In the long-run, transport and communications spending have a negative relation to growth, while energy spending has positive effects on growth. The negative long-run impacts of transport and communications spending on economic growth are not the same as the positive impacts of infrastructure spending found in previous studies.

There are several reasons that might explain the negative effect of transport and communications spending. First, as Devarajan et al. (1996) argued, this can be explained by the excessive use of capital expenditure due to low institutional quality which is particularly common in developing countries. Second, government spending in transport and communications used in the paper contains both capital and current expenditure, but other studies that found a positive correlation between transport and communications spending and growth are likely to include public investment only. Finally, the negative impact of transport and communications spending might indicate that the existing level of government spending is above the optimal level. As shown in Table 3.6, the mean value for transport and communications spending relative to GDP (1.7%) (or total government expenditure) is much higher than that for the energy ratio (0.4%). This might suggest that energy spending is likely to be in the range in which additional government spending can be productive, while transportation and communication spending may just be inefficiently substituting for private sector spending. Both the transport and communications sectors are more likely to attract higher private sector participation compared to the energy sector.

On the other hand, the long-run effect of social spending (education and health) is positively correlated to growth and its impact is statistically significant. The result also indicates that a long-run positive relationship between education spending and growth coexists with a negative short-run relationship. The intuition might be that government spending on human capital will start generating positive returns to growth only in the long-run, and in the short-run, increasing the share of education spending rather than other productive spending will be harmful to growth. The results are statistically significant and

economically important. As for health spending, its short-run impacts are positive when an increase in health spending is adjusted by a decrease in other spending. This implies that increasing the spending share on health will be beneficial to growth only when the overall government expenditure does not increase and the government resources are allocated more efficiently.

The effects of the components of government spending are large and very significant. Quantifying the long-run coefficients of the components of government spending, a one standard deviation increase in education spending as a ratio to GDP (i.e. the difference between Indonesia and Republic of Korea, or Mexico and Netherlands) increases the growth rates in the long-run by around 1.6 percent. On the other hand, one standard deviation increase in education spending as a ratio to total expenditure (the difference between Brazil and Switzerland) increases the growth rates by 0.5 percent.

As for the control variables, the expected sign of initial income, investment, and inflation are negative, positive, and negative, respectively. The standard results that the empirical growth literature find in terms of the relationship between control variables and the growth rate in real GDP per capita are found for most cases. That is, the size of government, the initial income, and the inflation rate are negatively related to growth, while investment is positively related to growth for most cases. The exception is the long-run coefficients of investment in columns [3] and [4] which have the negative and significant impacts on the growth rate in real GDP per capita[33].

[33] Trade openness variable was originally included in regressions as one of control variables. As none of the coefficients of the trade openness variable was statistically significant, it was dropped.

3.5.1 Analysis of Country Specific Effects

Tables 3.9.1 through 3.9.4 report the country specific results showing the short-run coefficients on government spending and control variables for each country.

As shown in Table 3.8 column [1], the estimate of the error-correction term which is the mean of the corresponding coefficients across countries is not statistically significant. Table 3.9.1 reveals that in fact none of the estimates of the error-correction term is statistically significant. On the other hand, in Table 3.9.2, the estimate of the error-correction term is statistically significant and no less than -2 for twelve out of twenty-two countries. The results are summarized below, which show the number of positive and negative estimates for three sets of regressions shown in Tables 3.9.2 through 3.9.4.

The Number of Positive and Negative Short-Run Estimates for Table 3.9.2*

	All		**Region**					
			Latin America		**East Asia**		**Europe**	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Transport and communications	13 (3)	9 (2)	4 (2)	3 (2)	5 (0)	1 (0)	4 (1)	5 (0)
Energy	11 (3)	11 (4)	4(1)	3 (1)	3 (0)	3 (2)	4 (2)	5 (1)
Education	12 (5)	10 (3)	7 (3)	-	2 (1)	4 (1)	3 (1)	6 (2)
Health	13 (4)	9 (5)	2 (1)	5 (3)	5 (1)	1 (1)	6 (2)	3 (1)
GG consumption expenditure	2 (0)	20 (9)	-	7 (2)	-	6 (2)	2 (0)	7 (5)

* The figure in the parentheses shows the number of countries which estimates are statistically significant.

The estimated short-run coefficients on the components of government spending indicate a relatively large variation across countries. In other words, almost half of twenty-

two countries have positive estimates while the remaining have negative ones. For transport and communications spending, of the five estimates significantly different from zero either at the 1 or 5 percent level, three are positive and two are negative. As for spending on energy, education, and health, seven (three positive and four negative), eight (five positive and three negative), and nine (four positive and five negative) estimates are statistically significant, respectively.

The exception is the coefficients on general government consumption expenditure in which a majority of countries have negative estimates while only a few have positive ones. Of the nine estimates significant at least at the 10 percent level, all are negative.

The Number of Positive and Negative Short-Run Estimates for Table 3.9.3*

	All		**Region**					
			Latin America		**East Asia**		**Europe**	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Transport and communications	15 (7)	7 (2)	4 (4)	3 (2)	5 (1)	1 (0)	6 (2)	3 (0)
Energy	14 (2)	8 (2)	4(1)	3 (1)	4 (0)	2 (0)	6 (1)	3 (1)
Education	14 (7)	8 (2)	7 (5)	-	2 (1)	4 (2)	5 (1)	4 (0)
Health	14 (3)	8 (3)	3 (1)	4 (2)	5 (2)	1 (1)	6 (0)	3 (0)
Total expenditure	3 (0)	19 (11)	2 (0)	5 (4)	1 (0)	5 (1)	-	9 (6)

* The figure in the parentheses shows the number of countries which estimates are statistically significant.

In Tables 3.9.3 and 3.9.4 the estimate of the error-correction term is statistically significant and no less than -2 for five out of twenty-two countries. The estimated coefficients vary in

sign and magnitude, but the cross-country variation is smaller compared to that of the results shown in Table 3.9.2. In other words, a majority of the estimates are positive, while the rest are negative. Spending on transport and communications as well as education has seven significantly positive and two negative estimates, while that on energy (health) has two (three) significantly positive and two (three) significantly negative ones. Again, the exception is the coefficients on total government expenditure in which a majority of the estimates are negative while only a few are positive. Also, all the significant estimates are negative. Only difference between Tables 3.9.3 and 3.9.4 is the estimated coefficients on total government expenditure which are mostly negative. In Table 3.9.4, of the three positive estimates, two are significant at the 1 percent level.

The Number of Positive and Negative Short-Run Estimates for Table 3.9.4*

	All		**Region**					
			Latin America		**East Asia**		**Europe**	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Transport and communications	15 (7)	7 (2)	4 (4)	3 (2)	5 (1)	1 (0)	6 (2)	3 (0)
Energy	14 (2)	8 (2)	4(1)	3 (1)	4 (0)	2 (0)	6 (1)	3 (1)
Education	14 (7)	8 (2)	7 (5)	-	2 (1)	4 (2)	5 (1)	4 (0)
Health	14 (3)	8 (3)	3 (1)	4 (2)	5 (2)	1 (1)	6 (0)	3 (0)
Total expenditure	3 (2)	19 (12)	3 (2)	4 (3)	-	6 (3)	-	9 (6)

* The figure in the parentheses shows the number of countries which estimates are statistically significant.

There are a few patterns and regional differences detected in the analysis of the

short-run coefficients. First, in the European region, both general government consumption expenditure and total expenditure seem to have significantly negative effects on the growth rate in real GDP per capita, but the impacts of other spending appear rather marginal. These results are in line with a series of empirical literature that found the negative effects of public spending, particularly in developed countries. Afonso and Furceri (2008) also show that larger government size (in terms of total government expenditure) has a negative impact on the real growth per capita GDP both for the OECD and EU countries. In addition, in industrial European countries automatic stabilizers are big (represented by large government size) so that in those countries, the beneficial effect of functional expenditures might have been concealed by the overall government size. The literature on automatic stabilizers pointed out that those countries with larger government shares benefit from more effective automatic stabilizers.

Second, in the East Asian region the positive effects of transport and communications as well as health spending appear dominant. As shown in Figure 3.1 panel (b), government spending on transport and communications, and health has been roughly constant in the region over the past 30 years. This might suggest that the levels of those government expenditures are likely to be below the optimal value in which increasing levels of government spending further is still productive.

Third, the negative short-run effect of transport and communications spending is found mainly in middle-and high-income countries such as Brazil, Chile, Republic of Korea, and some industrial European countries. As explained in the earlier section, this might indicate that the level of transport and communications spending is above the

threshold in these countries and the beneficial effects of government spending turn negative as the level of spending rises.

Finally, positive short-run effects on education spending concentrate in Latin American countries. In fact, the short-run impacts of education spending on the growth rate in real GDP per capita are positive for all countries in the region. In other two regions, the negative short-run effects seem more apparent. The possible explanation for this is the change in government spending trends in the Latin American region over time. Kaufman et al. (2001) report that government expenditures have become more in favor of social spending (i.e. social security, education, and health care) in the Latin American region since 1970s, and less so of infrastructure spending. In other words, an increase in education spending has been to some extent adjusted by a decrease in the infrastructure share in the government budget.

Tables 3.10.1 through 3.10.3 present the results obtained by the PMG and the alternative two estimators: the MG and DFE estimators. The estimation with alternative estimators returned quite different results from those with the PMG estimator. The signs and statistical significance of both long-and short-run coefficients drastically changed. Moreover, the estimate of error-correction term from each alternative model is no longer statistically significant, and therefore no long-run relationship is found.

The Hausman test statistic for the entire model is negative under the null hypothesis of no difference between the MG and PMG estimates and thereby no p-values are calculated. Because the results with other estimators show no sign of long-run relationship, I conclude that the PMG estimator is the valid estimator. In addition, the negative

Hausman test statistic can be interpreted as strong evidence that the both estimates should not be statistically different[34], and thereby it will be concluded that the PMG estimator under the null is preferred.

Moreover, the Hausman test was performed for the coefficients on each of government spending variables for the models [2] through [4]. The calculated Hausman test statistic for all spending variables is positive and small enough (the maximum value is 1.3), and is distributed $\chi^2(1)$. Therefore, it failed to reject the null hypothesis of no difference between the MG and PMG estimators. Since both are consistent estimators, and the PMG is also the efficient estimator, I conclude that the PMG estimator under the null hypothesis is preferred.

3.6. Conclusion

This paper investigated the impacts of the components of government spending on real macroeconomic performance in the short-and long-runs. The paper further examined differential impacts of the components of government spending: infrastructure and social spending on economic growth. The pooled error-correction model is used to estimate the impacts at different time horizons through the PMG estimator on a panel data of twenty-two countries from three regions: East Asia, Latin America, and Europe for the period 1970-2006.

[34] Hausman and McFadden (1984) state that a negative Hausman test statistic may occur when the difference in variance matrices is not positive semi-definite. They interpret a negative Hausman test statistic as strong evidence that IIA holds, that is, it fails to reject the null hypothesis that the difference in coefficient values is not systematic.

The results suggest that government spending which is considered productive such as infrastructure, education, and health spending has a long-run positive relationship with growth, while spending which is considered unproductive such as consumption expenditures appears to be strongly negatively correlated to growth both in the long-and short-runs. The exception is transport and communications spending which present strong negative impacts on growth in the long-run. This could be the case that productive expenditure became unproductive due to excessive use, as explained by Debarajana et al. (1996). Another possible explanation would be that transport and communications spending used in the analysis contain both capital and current expenditures, but a number of studies found a positive correlation use the data that includes public investment only. The results also show that expansionary fiscal policy on government spending on infrastructure and health is growth enhancing at business cycle frequencies. The positive returns of education spending to growth are identified, not in the short-run, but only in the long-run. This is consistent with the idea that education is a long-run investment.

To conclude, the results identify differential impacts of the components of government spending on economic growth and highlight the importance of the composition of government spending on economic activity in both the short-and long-runs. Either implementing discretionary fiscal stimulus packages or conducting fiscal adjustments, it is critical for the governments to take these issues into consideration.

Table 3.1 List of Sample Countries

Region (the number of countries)	Country name
East Asia (6)	
	Indonesia
	Korea, Republic
	Malaysia
	Thialand
	Singapore
	Philippines
Latin America (7)	
	Argentina
	Bolivia
	Brazil
	Chile
	Colombia
	Mexico
	Peru
Europe (9)	
	Austria
	Denmark
	France
	Germany
	Netherlands
	Norway
	Sweden
	Switzerland
	United Kingdom

Table 3.2 Time Coverage of Government Spending by Sector and Country (Final Dataset)

	Final data				
	Transport & com.	Energy	Education	Health	Total Expenditure
East Asia					
Indonesia	73-04	73-04	73-04	73-04	72-04
Korea, Republic	70-06	70-05	70-06	70-05	70-06
Malaysia	72-06	72-06	72-06	72-06	72-06
Philippines	85-06	85-06	90-06	90-06	85-06
Singapore	70-06	70-06	70-06	70-06	70-06
Thailand	72-06	72-06	72-06	72-06	72-06
Latin America					
Argentina	82-04	82-04	70-06	70-06	78-06
Bolivia	87-06	87-06	70-06	70-06	86-06
Brazil	80-06	80-06	70-05	70-06	70-06
Chile	73-06	80-06	73-06	70-06	72-06
Colombia	80-06	80-06	70-06	71-06	70-06
Mexico	72-06	72-06	70-06	71-06	70-06
Peru	77-06	70-06	70-06	70-06	70-06
Europe					
Austria	70-94	70-94	70-06	70-06	70-06
Denmark	70-06	70-06	70-06	70-06	70-06
France	75-93	75-93	75-93	75-93	72-97
Germany	74-96	74-96	74-96	74-96	70-98
Norway	72-06	72-06	72-06	72-06	72-06
Sweden	70-99	70-99	70-04	70-04	70-06
Switzerland	70-05	70-05	70-05	70-05	70-05
United Kingdom	72-06	72-06	79-06	72-06	70-06
Netherlands	74-97	74-97	74-97	74-97	73-97

Table 3.3 Availability of Government Spending by the Level of Government and Sector (Final Dataset)

		Federal (consolidated central gov)					Sub-national (state gov)					Sub-national (local gov)					General gov				
		Transcom	Energy	Education	Health	Total	Transcom	Energy	Education	Health	Total	Transcom	Energy	Education	Health	Total	Transcom	Energy	Education	Health	Total
EAP																					
	Indonesia	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					
	Korea, Rep.	x	x	x	x	x															
	Malaysia	x	x	x	x	x					x					x					
	Philippines	x	x	x	x	x							x	x				x	x		
	Singapore	x	x	x	x	x															
	Thailand	x	x	x	x	x						x	x	x	x	x					
EURO																					
	Austria	x	x	x	x	x	x	x	x	x	x			x	x	x			x	x	x
	Denmark	x	x	x	x	x						x	x	x	x	x					
	France	x	x	x	x	x						x	x	x	x	x			x	x	x
	Germany	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					
	Norway	x	x	x	x	x						x	x	x	x	x					
	Sweden	x	x	x	x	x										x					
	Switzerland	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					
	UK	x	x	x	x	x						x	x	x	x	x					
	Netherlands	x	x	x	x	x						x	x	x	x	x			x	x	x
LAC																					
	Argentina	x	x	x	x	x	x	x	x	x							x	x	x	x	x
	Bolivia	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Brazil	x	x	x	x	x					x					x	x	x	x	x	x
	Chile	x	x	x	x	x								x	x	x	x	x	x	x	
	Colombia	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
	Mexico	x	x	x	x	x					x					x	x	x	x	x	x
	Peru	x	x	x	x	x					x					x	x	x	x	x	x

Table 3.4 Summary of Data Availability for Countries Excluded from the Sample Data (Source: GFS database)

		Central Government (consolidated)					State Government					Local Government					General Government				
Country Name	Region	Transcom	Energy	Education	Health	Total Exp.	Transcom	Energy	Education	Health	Total Exp.	Transcom	Energy	Education	Health	Total Exp.	Transcom	Energy	Education	Health	Total Exp.
Cambodia	EAP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
China	EAP	0	0	0	0	0	5	5	5	5	5	9	9	11	11	4	0	0	0	0	0
Hong Kong, China	EAP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Korea, Dem. Rep.	EAP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lao PDR	EAP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mongolia	EAP	10	10	10	10	12	0	0	0	0	0	11	10	11	11	12	1	1	1	1	2
Myanmar [a]	EAP	33	20	33	33	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Papua New Guinea	EAP	0	0	0	0	0	3	3	3	3	3	1	0	1	1	5	0	0	0	0	0
Taiwan, China	EAP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vietnam	EAP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	0
Albania	EURO	4	4	4	4	7	0	0	0	0	0	4	1	4	4	4	2	2	2	2	2
Armenia	EURO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azerbaijan	EURO	5	1	6	6	6	0	0	0	0	0	6	0	6	6	6	0	0	0	0	0
Belarus	EURO	14	12	15	15	15	0	0	0	0	0	15	15	15	15	15	4	4	4	4	4
Bosnia and Herzegovina	EURO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bulgaria	EURO	19	19	19	19	19	0	0	0	0	0	19	6	19	19	19	17	17	17	17	5
Croatia	EURO	11	3	11	11	16	0	0	0	0	0	12	5	12	12	13	0	0	0	0	5
Czech Republic	EURO	14	14	14	14	14	0	0	0	0	0	14	13	14	14	14	7	7	7	7	7
Estonia	EURO	11	8	15	15	16	0	0	0	0	0	11	8	15	15	16	0	0	5	5	7
Georgia	EURO	10	10	10	10	10	0	0	0	0	0	11	4	11	11	11	4	4	4	4	4
Hungary	EURO	21	21	25	25	26	0	0	0	0	0	10	20	25	25	26	0	0	5	5	11
Latvia	EURO	13	11	13	13	13	0	0	0	0	0	13	12	13	13	13	5	5	5	5	5
Lithuania	EURO	11	11	14	14	15	0	0	0	0	0	13	11	14	14	15	4	4	7	7	7
Macedonia, FYR	EURO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moldova	EURO	11	11	11	11	12	0	0	0	0	0	13	11	13	13	13	5	5	5	5	4
Poland	EURO	13	13	13	13	18	0	0	0	0	0	8	12	13	13	18	6	6	6	6	6
Romania	EURO	26	26	36	36	36	0	0	0	0	0	25	1	25	26	36	4	4	4	4	4
Russian Federation	EURO	9	9	11	11	11	2	2	2	2	2	11	9	11	11	11	7	7	7	7	7
Slovak Republic	EURO	11	11	11	11	11	0	0	0	0	0	11	8	11	11	11	7	7	7	7	7
Slovenia	EURO	14	14	14	14	15	0	0	0	0	0	14	5	14	14	15	7	7	7	7	7
Ukraine	EURO	6	6	8	8	8	0	0	0	0	0	8	8	8	8	8	4	4	6	6	6
Belgium	EURO	19	11	30	30	37	0	0	11	11	12	0	0	11	11	29	0	0	11	11	12
Finland [b]	EURO	29	29	34	34	35	0	0	0	0	0	0	0	8	8	37	2	2	8	8	9
Greece	EURO	18	12	18	18	34	0	0	0	0	0	7	0	5	0	24	0	0	11	11	11
Ireland	EURO	16	16	20	20	37	0	0	0	0	0	22	22	30	29	37	0	0	11	11	12
Italy	EURO	14	0	25	25	34	0	0	0	0	0	0	0	11	11	20	0	0	11	11	12
Portugal	EURO	0	2	16	16	32	0	0	0	0	13	0	0	4	4	23	4	4	7	7	10
Spain [c]	EURO	29	29	34	34	37	8	8	13	13	27	5	5	10	10	37	2	2	7	7	12
Costa Rica	LAC	29	21	29	29	35	0	0	0	0	0	1	0	0	1	23	0	0	0	0	5
Cuba	LAC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dominican Republic	LAC	28	29	30	30	34	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0
Ecuador	LAC	0	0	0	0	0	0	0	0	0	7	0	0	0	0	7	0	0	0	0	0
El Salvador	LAC	8	7	8	8	10	0	0	0	0	0	0	0	0	0	7	2	3	3	3	5
Guatemala	LAC	8	8	8	8	12	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0
Haiti	LAC	7	6	7	7	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Honduras	LAC	8	4	8	8	8	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
Jamaica	LAC	14	13	14	14	26	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
Nicaragua	LAC	16	6	16	16	26	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0
Panama	LAC	29	21	29	29	29	0	0	0	0	0	7	0	20	15	23	0	0	0	0	0
Paraguay	LAC	21	5	21	21	32	0	0	0	0	2	0	0	4	4	20	0	0	0	0	2
Puerto Rico	LAC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trinidad and Tobago	LAC	14	14	14	14	14	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Uruguay	LAC	26	21	30	30	35	0	0	0	0	0	0	0	0	0	21	0	0	0	0	0
Venezuela, RB	LAC	23	23	24	24	36	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0

(a) Myanmer is excluded as dependent and control variables are not available.
(b) (c) Finalnd and Spain are excluded as the quality of some expenditure data are questionable.

Figure 3.1 Time Path of Government Spending by Sector (% of GDP)

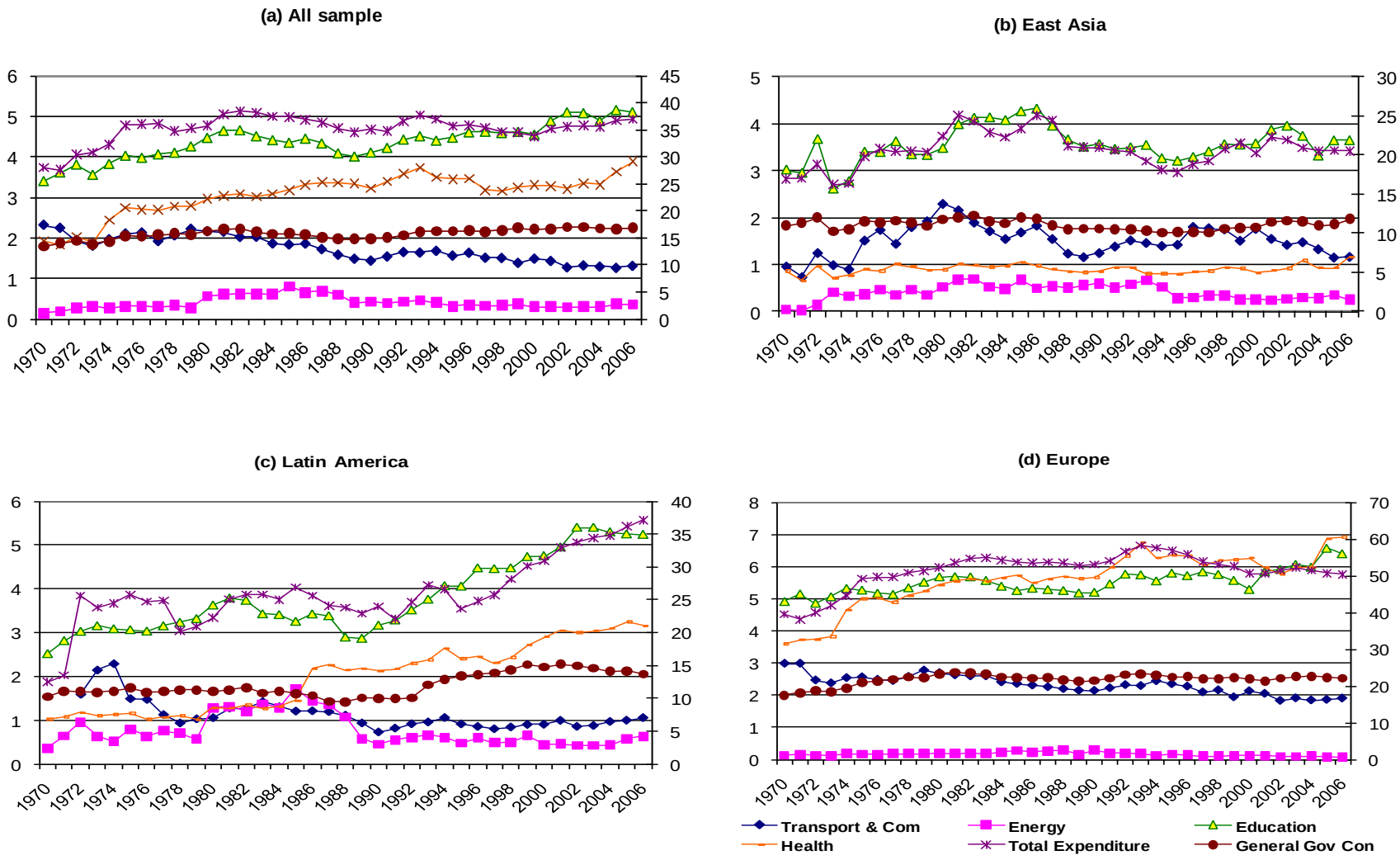

Figure 3.2 Structure of the Public Sector

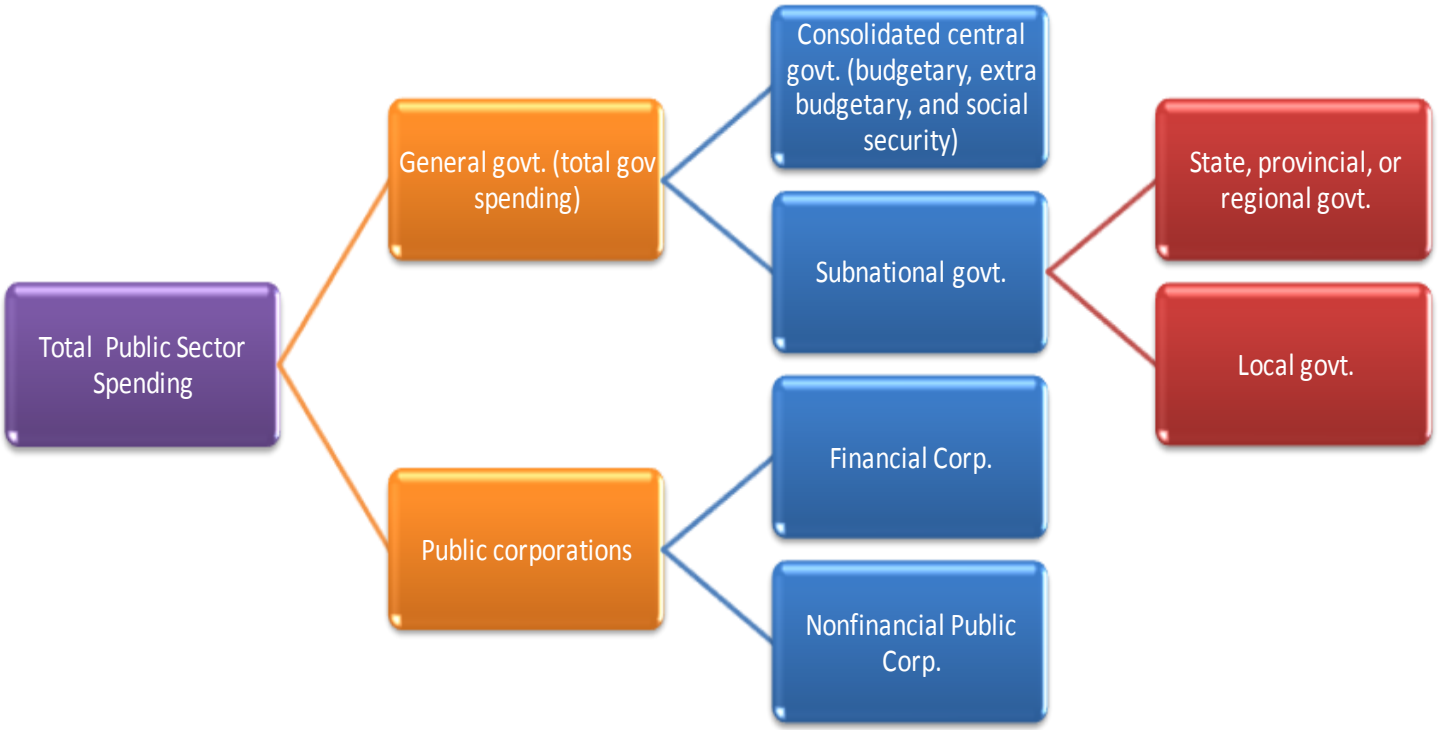

Figure 3.3 Structure of Total Government Spending

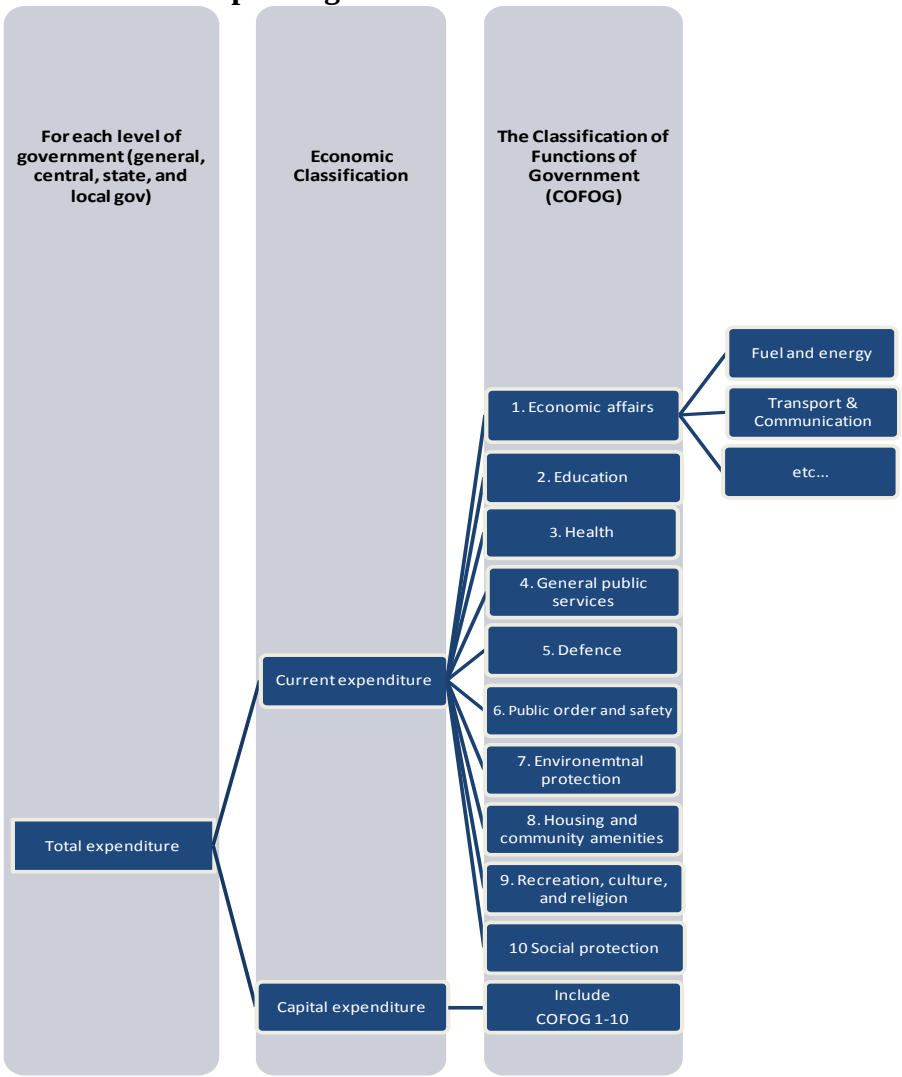

Table 3.5 Definition and Sources of Variables used in Regression Analysis

Variable	Variable name	Definition	Source
Components of government expenditures:		**Government expenditure (% of GDP)**	GFS database , The IMF and other misalaneous sources.
Transport and communications	transcom_gdp	Trransport and communications (% of GDP)	
Energy	energy_gdp	Energy (% of GDP)	
Education	education_gdp	Education (% of GDP)	
Health	health_gdp	Heatlh (% of GDP)	
		Government expenditure (% of total expenditure)	
Transport and communications	transcom_totexp	Trransport and communications (% of total expenditure)	
Energy	energy_totexp	Energy (% of total expenditure)	
Education	education_totexp	Education (% of total expenditure)	
Health	health_totexp	Heatlh (% of ttal expenditure)	
Total expenditure	totexp_gdp	Total government expendiure (% of GDP)	GFS database, The IMF.
General government final consumption expenditure	gg_con_gdp	Government final consumption expenditure (% of GDP).	WDI databse, The Wolrd Bank.
Real GDP per capita	rgdpch	Real GDP per capita (Int'l $ in 2000 constant prices)	World Penn Table 6.2
Real GDP per capita growth	grgdpch	Log difference of real GDP per capita	World Penn Table 6.2
Initital level of real GDP per capita	l.rgdpch	Initial value of ratio of total GDP to total polulation (GDP is in 2000 int'l $)	World Penn Table 6.2
Investment	inv_gdp	Total investment (phisical capital investment) (% of GDP)	WDI databse, The Wolrd Bank.
CPI		Consumer price index (2000=100) at the end of the year	IFS, The IMF.
Inflation	inflation	Annual percentage change in CPI	IFS, The IMF.

Table 3.6 Descriptive Statistics

Country		Transport & Com (% of GDP)	Energy (% of GDP)	Education (% of GDP)	Health (% of GDP)	Total Exp. (% of GDP)	GG Consump. Exp. (% of GDP)	Transport & Com (% of toal exp)	Energy (% total exp)	Education (% of total exp)	Health (% of total exp)	Investment (% of GDP)	Real GDP per cap	Real GDP per cap growth	Inflation
All sample	**Min**	0.061	0.001	0.731	0.074	11.43	2.98	0.27	0.00	3.73	0.25	9.85	1359.57	-16.34	-1.80
	Mean	1.714	0.423	4.393	3.094	35.41	15.74	5.29	1.65	14.04	8.07	23.46	12679.73	2.36	68.83
	Median	1.484	0.226	4.103	2.003	31.00	13.90	4.86	0.68	13.06	7.53	22.25	10531.62	2.43	6.00
	Max	4.810	3.788	11.693	10.123	75.56	29.94	16.89	16.46	32.90	23.69	48.64	34759.02	20.06	11749.60
	Std. dev.	1.059	0.508	1.735	2.592	16.58	5.93	3.14	2.22	4.93	4.74	6.32	8508.81	3.86	544.93
	No. of obs.	660	660	724	730	722	813	659	659	690	694	809	763	762	813
East Asia	**Min**	0.112	0.002	0.731	0.074	12.99	5.69	0.79	0.01	3.73	0.36	11.37	1359.57	-9.44	-1.80
	Mean	1.518	0.420	3.578	0.904	20.80	11.08	7.14	1.94	17.20	4.25	28.88	7299.57	4.24	7.50
	Median	1.440	0.236	3.304	0.928	20.11	10.85	7.03	1.14	18.18	4.02	28.16	4240.42	4.70	5.10
	Max	4.213	2.425	8.122	2.273	37.65	18.78	16.89	11.95	26.49	10.92	48.64	29433.77	20.06	58.40
	Std. dev.	0.781	0.464	1.275	0.565	4.45	2.20	3.01	2.09	4.41	2.49	7.54	6547.30	4.44	8.05
	No. of obs.	199	199	193	192	199	221	198	198	193	192	221	207	207	221
Latin America	**Min**	0.061	0.001	0.935	0.251	11.43	2.98	0.27	0.01	5.19	1.05	9.85	2443.06	-16.34	-1.20
	Mean	1.042	0.761	3.807	1.972	26.63	11.96	4.16	3.10	15.51	8.11	20.17	6262.41	1.25	203.62
	Median	0.840	0.609	3.600	1.602	24.08	11.03	3.15	2.30	14.68	6.61	20.16	6053.36	1.65	20.00
	Max	4.246	3.788	11.693	5.093	56.67	22.73	12.67	16.46	32.90	23.69	34.29	12677.92	10.68	11749.60
	Std. dev.	0.845	0.643	1.579	1.244	10.04	3.48	3.23	2.74	5.08	4.62	4.11	2520.62	4.47	952.75
	No. of obs.	196	196	256	256	223	259	196	196	222	220	259	241	241	259
Europe	**Min**	0.735	0.001	2.032	0.099	24.25	13.12	1.11	0.00	4.72	0.25	15.21	12738.17	-9.75	-1.08
	Mean	2.358	0.175	5.511	5.604	51.64	21.77	4.74	0.35	10.63	10.64	22.41	21125.03	1.98	4.69
	Median	2.221	0.119	5.520	5.859	51.38	21.58	4.05	0.23	10.39	11.10	21.87	20989.07	2.13	3.30
	Max	4.810	1.331	9.320	10.123	75.56	29.94	14.60	2.42	16.39	19.00	37.94	34759.02	8.35	24.20
	Std. dev.	1.017	0.176	1.562	2.249	10.56	3.36	2.51	0.38	2.49	4.24	4.18	4525.13	2.10	3.74
	No. of obs.	265	265	275	282	300	333	265	265	275	282	329	315	314	333

Table 3.7 Correlation of Variables

All variables are in logs except for real GDP per cap growth.

		Transport & Com (% of GDP)	Energy (% of GDP)	Education (% of GDP)	Health (% of GDP)	Total Exp. (% of GDP)	GG Consump. Exp. (% of GDP)	Transport & Com (% of total exp)	Energy (% total exp)	Education (% of total exp)	Health (% of total exp)	Investment (% of GDP)	Real GDP per cap	Real GDP per cap growth	Inflation
All sample	Transport & Com (% of GDP)	1													
	Energy (% of GDP)	-0.1435*	1												
	Education (% of GDP)	0.3993*	-0.1088*	1											
	Health (% of GDP)	0.2869*	-0.1179*	0.6749*	1										
	Total Exp. (% of GDP)	0.4130*	-0.1425*	0.6921*	0.7549*	1									
	GG Consump. Exp. (% of GDP)	0.3951*	-0.1478*	0.6354*	0.5366*	0.8196*	1								
	Transport & Com (% of total exp)	0.8013*	-0.0646	-0.0157	-0.1849*	-0.2139*	-0.1171*	1							
	Energy (% total exp)	-0.2493*	0.9620*	-0.2884*	-0.3154*	-0.4073*	-0.3667*	-0.0003	1						
	Education (% of total exp)	-0.1124*	0.0656	0.1979*	-0.2582*	-0.5706*	-0.3937*	0.2612*	0.2228*	1					
	Health (% of total exp)	0.1498*	-0.0786*	0.5082*	0.9220*	0.4421*	0.2381*	-0.1282*	-0.1930*	-0.0182	1				
	Investment (% of GDP)	0.1104*	-0.2551*	-0.0959*	-0.1906*	-0.2508*	-0.1863*	0.3101*	-0.1566*	0.2360*	-0.1337*	1			
	Real GDP per cap	0.3128*	-0.4049*	0.5044*	0.5877*	0.6915*	0.6951*	-0.1190*	-0.5588*	-0.3597*	0.4005*	0.051	1		
	Real GDP per cap growth	-0.0138	-0.1037*	-0.0803*	-0.1486*	-0.2017*	-0.1216*	0.1267*	-0.0374	0.1723*	-0.1189*	0.3947*	-0.0534	1	
	Inflation	-0.3158*	0.3245*	-0.3862*	-0.2365*	-0.2758*	-0.4186*	-0.1832*	0.3678*	-0.0231	-0.1161*	-0.1063*	-0.4316*	-0.2754*	1
East Asia	Transport & Com (% of GDP)	1													
	Energy (% of GDP)	0.2103*	1												
	Education (% of GDP)	0.3893*	-0.077	1											
	Health (% of GDP)	0.2932*	-0.1418*	0.5830*	1										
	Total Exp. (% of GDP)	0.6130*	0.2270*	0.5405*	0.5167*	1									
	GG Consump. Exp. (% of GDP)	0.3061*	0.0833	0.7377*	0.2280*	0.4180*	1								
	Transport & Com (% of total exp)	0.9458*	0.1506*	0.2488*	0.1416	0.3232*	0.1901*	1							
	Energy (% total exp)	0.1376	0.9938*	-0.1398	-0.2031*	0.1172	0.0283	0.1166	1						
	Education (% of total exp)	0.0698	-0.2197*	0.8607*	0.3801*	0.0369	0.5951*	0.0697	-0.2279*	1					
	Health (% of total exp)	0.1530*	-0.2139*	0.5038*	0.9736*	0.3077*	0.1298	0.058	-0.2527*	0.4124*	1				
	Investment (% of GDP)	0.0702	-0.3607*	0.1505*	0.1374	-0.1523*	0.0957	0.1485*	-0.3549*	0.2552*	0.1865*	1			
	Real GDP per cap	-0.0905	-0.6901*	0.3477*	0.1650*	-0.0305	0.1724*	-0.0899	-0.6973*	0.4296*	0.1910*	0.4762*	1		
	Real GDP per cap growth	-0.2547*	-0.1167	-0.0055	-0.0606	-0.3045*	0.1048	-0.1810*	-0.0853	0.1720*	0.0105	0.3302*	0.049	1	
	Inflation	-0.1511*	0.3095*	-0.5055*	-0.3912*	-0.2797*	-0.3968*	-0.0644	0.3609*	-0.4314*	-0.3612*	-0.0746	-0.5157*	-0.1502*	1
Latin America	Transport & Com (% of GDP)	1													
	Energy (% of GDP)	0.2201*	1												
	Education (% of GDP)	0.2489*	0.0925	1											
	Health (% of GDP)	-0.1233	0.1645*	0.4702*	1										
	Total Exp. (% of GDP)	0.0378	0.0817	0.6238*	0.5205*	1									
	GG Consump. Exp. (% of GDP)	0.098	0.0603	0.5314*	0.2448*	0.5842*	1								
	Transport & Com (% of total exp)	0.9281*	0.1766*	0.0255	-0.2918*	-0.3370*	-0.121	1							
	Energy (% total exp)	0.2133*	0.9643*	-0.0554	0.0424	-0.1850*	-0.0878	0.2681*	1						
	Education (% of total exp)	0.2230*	0.0092	0.4390*	-0.1039	-0.4284*	-0.0289	0.3892*	0.14	1					
	Health (% of total exp)	-0.1642*	0.1375	0.1246	0.8656*	0.023	-0.0504	-0.1422*	0.1493*	0.1202	1				
	Investment (% of GDP)	-0.3811*	0.2093*	-0.2573*	-0.2417*	-0.2299*	-0.1735*	-0.2547*	0.2725*	0.0336	-0.1499*	1			
	Real GDP per cap	-0.3133*	0.4141*	-0.0548	0.3699*	0.1764*	-0.0164	-0.3348*	0.3840*	-0.1790*	0.4185*	0.3171*	1		
	Real GDP per cap growth	0.0156	0.0734	0.0208	0.0079	-0.1532*	-0.122	0.0613	0.1053	0.2024*	0.0458	0.2714*	0.086	1	
	Inflation	-0.0291	0.0829	-0.3479*	-0.2015*	-0.0167	-0.2316*	-0.012	0.0981	-0.3259*	-0.1606*	0.0819	0.0249	-0.3539*	1
Europe	Transport & Com (% of GDP)	1													
	Energy (% of GDP)	-0.1880*	1												
	Education (% of GDP)	0.2534*	0.0339	1											
	Health (% of GDP)	0.3565*	-0.0371	0.6192*	1										
	Total Exp. (% of GDP)	0.037	0.0931	0.6212*	0.5317*	1									
	GG Consump. Exp. (% of GDP)	-0.3945*	0.4370*	0.0431	-0.4224*	0.1753*	1								
	Transport & Com (% of total exp)	0.9077*	-0.2126*	-0.0207	0.117	-0.3856*	-0.4676*	1							
	Energy (% total exp)	-0.1944*	0.9862*	-0.0665	-0.1212*	-0.073	0.3968*	-0.1489*	1						
	Education (% of total exp)	0.2886*	-0.0216	0.7227*	0.3152*	-0.0928	-0.0806	0.3311*	0.005	1					
	Health (% of total exp)	0.3860*	-0.0673	0.5201*	0.9708*	0.3132*	-0.5188*	0.2382*	-0.1142	0.3795*	1				
	Investment (% of GDP)	0.5700*	-0.2519*	0.021	0.1943*	-0.2249*	-0.5383*	0.6477*	-0.2042*	0.2355*	0.2821*	1			
	Real GDP per cap	0.1229*	0.0041	0.2929*	0.1560*	0.1855*	0.1906*	0.0515	-0.0202	0.2662*	0.1385*	-0.2364*	1		
	Real GDP per cap growth	-0.0036	-0.1421*	-0.2016*	-0.0134	-0.1164*	-0.2633*	0.0374	-0.1268*	-0.1766*	0.0123	0.2499*	-0.1135*	1	
	Inflation	-0.0684	0.1461*	-0.0739	-0.115	-0.1530*	-0.0878	0.0087	0.1745*	0.0387	-0.0875	0.3518*	-0.6382*	-0.066	1

Table 3.8 The Long-and Short-Run Effects of the Components of Government Expenditures on Economic Growth

	[1] All sample (a)		[2] All sample (b)		[3] All sample (c)		[4] All sample (d)	
Variables	Coef.	Std. error	Coef.	Std. error	Coef.	Std. error	Coef.	Std. error
Long-run coef.								
Transport and communications	-2.473	[4.090]	-0.669***	[0.192]	-0.943***	[0.213]	-0.943***	[0.213]
Energy	-0.9	[1.493]	0.056	[0.130]	0.906***	[0.194]	0.906***	[0.194]
Education	-6.641	[10.738]	3.956***	[1.080]	1.239***	[0.297]	1.239***	[0.297]
Health	-3.432	[5.604]	-0.990**	[0.407]	0.442***	[0.149]	0.442***	[0.149]
GG consump exp / Total exp			-14.746***	[3.828]	-8.536***	[1.732]	-6.893***	[1.379]
Initial GDP per cap	-5.222	[8.453]	-5.506***	[1.482]	-4.641***	[0.942]	-4.641***	[0.942]
Investment	19.472	[31.316]	2.398***	[0.928]	-1.621***	[0.466]	-1.621***	[0.466]
Inflation	-0.277	[0.488]	-1.293***	[0.382]	-0.408***	[0.087]	-0.408***	[0.087]
Error-Correction coef. (Phi)	-0.02	[0.092]	-0.525***	[0.137]	-1.002**	[0.493]	-1.002**	[0.493]
Short-run coef.								
Δ Transport & com	0.742	[0.634]	1.055	[0.655]	2.085***	[0.742]	2.085***	[0.742]
Δ Energy	-0.637	[0.427]	-0.332	[0.482]	0.004	[0.221]	0.004	[0.221]
Δ Education	-2.492	[2.107]	-0.192	[2.641]	-0.939	[3.770]	-0.939	[3.770]
Δ Health	0.312	[1.428]	1.295	[1.327]	3.113**	[1.443]	3.113**	[1.443]
Δ GG consump exp / Total exp			-13.706***	[2.775]	-18.246***	[3.657]	-13.983***	[4.195]
Δ Initial GDP per cap	-92.222***	[9.330]	-42.211***	[11.861]	10.359	[52.069]	10.358	[52.068]
Δ Investment	21.709***	[3.188]	19.751***	[2.827]	17.214***	[2.137]	17.214***	[2.137]
Δ Inflation	-0.417	[0.317]	-0.738**	[0.317]	-1.076**	[0.547]	-1.076**	[0.547]
Intercept	2.628***	[0.592]	44.638***	[10.805]	74.903**	[34.282]	67.314**	[30.558]
No. of countries	22		22		22		22	
No. of obs.	554		554		554		554	

Notes: *The model is estimated by the pooled mean group estimator. The dependent variable is per capita real growth rate of GDP. Model specification: ARDL(1,1,1,1,1,1,1,1) for [1] and ARDL(1,1,1,1,1,1,1,1,1) for [2] - [4].*

(a) 4 exp (% of GDP), and control variables (initial GDP, investment, inflation).
(b) 4 exp (% of GDP), gg consump exp (% of GDP), and control variables (initial GDP, investment, and inflation).
(c) 4 exp (% of GDP), total exp (% of GDP), and control variables (initial GDP, investment, inflation).
(d) 4 exp (% of total exp), total exp (% of GDP), and control variables (initial GDP, investment, inflation).

Table 3.9.1 The Long-and Short-Run Effects of the Components of Government Expenditures on Economic Growth: Country Specific Coefficients [1]

Variables	All																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Latin America							East Asia						Europe								
		Argentina	Bolivia	Brazil	Chile	Colombia	Mexico	Peru	Indonesia	Korea, Rep	Malaysia	Philippines	Singapore	Thailand	Austria	Denmark	France	Germany	Netherlanc	Norway	Sweden	Switzerlan	United Kingdom
Long-run coef.																							
Transport and communications	-2.473																						
	[4.090]																						
Energy	-0.9																						
	[1.493]																						
Education	-6.641																						
	[10.738]																						
Health	-3.432																						
	[5.604]																						
GG consump exp / Total exp																							
Initial GDP per cap	-5.222																						
	[8.453]																						
Investment	19.472																						
	[31.316]																						
Inflation	-0.277																						
	[0.488]																						
Error-Correction coef.		-0.536	0	1.296	-0.563	-0.036	-0.272	0.684	-0.042	-0.081	-0.22	0.825	-0.273	-0.25	-0.309	0.026	-0.133	-0.315	-0.076	-0.041	-0.027	-0.115	0.024
(Phi)		[0.894]	[0.028]	[2.082]	[0.921]	[0.083]	[0.450]	[1.141]	[0.164]	[0.176]	[0.370]	[1.392]	[0.446]	[0.413]	[0.505]	[0.088]	[0.219]	[0.542]	[0.185]	[0.079]	[0.080]	[0.192]	[0.097]
Short-run coef.																							
Δ Transport & com		-1.78	0.268	1.102	-1.573***	-2.365**	2.201***	5.654***	-0.272	-1.445	-0.342	6.217	-0.601	1.72	3.609	-2.930*	4.905***	2.816	5.431	0.491	-2.216*	-3.962	-0.614
		[3.890]	[0.760]	[1.357]	[0.605]	[1.081]	[0.724]	[1.629]	[2.676]	[0.960]	[1.598]	[4.113]	[1.040]	[3.626]	[3.779]	[1.611]	[1.845]	[4.102]	[4.003]	[3.280]	[1.148]	[3.347]	[2.231]
Δ Energy		-1.353	0.22	0.302	-0.835	-0.332	0.539	-0.663	-1.931*	0.732	0.391	-8.558***	-0.789	0.596	-0.135	0.497	1.706***	-0.341	-1.555	0.103	-0.272	-2.290***	-0.056
		[1.795]	[0.196]	[0.421]	[1.370]	[0.632]	[0.666]	[0.634]	[1.027]	[0.606]	[0.756]	[2.616]	[1.030]	[0.737]	[0.352]	[0.324]	[0.619]	[1.097]	[1.529]	[0.606]	[0.643]	[0.628]	[0.262]
Δ Education		-0.116	0.999	12.275***	1.556	0.891	8.981***	17.455***	12.933**	1.169	-16.026***	-9.347	-8.917**	-13.213	-2.424	-2.367	-18.103***	-15.931***	-0.108	-1.866	-5.371*	-15.911**	-1.375
		[2.033]	[0.948]	[4.722]	[5.377]	[1.946]	[2.538]	[4.559]	[5.546]	[4.603]	[5.544]	[11.176]	[3.669]	[11.893]	[4.553]	[6.244]	[6.921]	[5.822]	[4.708]	[4.658]	[2.779]	[8.047]	[2.641]
Δ Health		1.419	-1.038***	9.404***	-5.559	-0.804	-1.290**	-0.774	-10.732**	0.624	6.993	6.848	-2.433	12.966**	-5.141	-5.397	1.258	12.370**	-13.795*	1.893	4.411**	-2.204	-2.165
		[2.798]	[0.401]	[2.752]	[4.484]	[1.033]	[0.546]	[4.102]	[4.268]	[1.974]	[5.653]	[5.606]	[4.140]	[6.264]	[6.341]	[4.016]	[2.459]	[6.206]	[8.309]	[5.476]	[1.845]	[1.415]	[6.588]
Δ GG consump exp / Total exp																							
Δ Initial GDP per cap		-48.985	-75.796***	-238.227	-89.187	-36.43	-61.25	-123.406	-78.212***	-74.566***	-114.880**	-172.94	-65.385	-74.458*	-93.332*	-113.329**	-70.017***	-59.15	-85.943***	-67.725***	-109.099**	-96.851***	-79.722***
		[89.116]	[26.393]	[208.079]	[89.182]	[23.200]	[44.422]	[111.994]	[19.869]	[19.610]	[38.859]	[144.377]	[50.258]	[43.402]	[52.500]	[10.993]	[26.018]	[53.631]	[23.045]	[19.350]	[12.483]	[19.460]	[12.152]
Δ Investment		47.062***	-0.554	3.686	25.886***	2.998	28.496***	0.492	6.615*	30.656***	16.039***	58.119***	29.971***	23.752***	28.410***	22.475***	17.007***	40.262***	25.501***	7.484**	20.374***	22.192***	20.667***
		[10.404]	[0.956]	[3.708]	[1.741]	[1.954]	[3.043]	[4.718]	[3.808]	[4.173]	[3.880]	[9.848]	[6.118]	[4.316]	[4.510]	[2.740]	[2.956]	[4.554]	[8.075]	[3.315]	[2.873]	[3.170]	[4.174]
Δ Inflation		-2.295***	0.257	-0.24	-3.655***	-0.28	-1.957***	-0.79	-1.063	-1.951***	0.142	3.782	1.414**	-0.694	-0.848	0.939	-1.774*	-0.429	0.216	-0.2	0.231	0.245	-0.233
		[0.700]	[0.234]	[0.325]	[0.849]	[1.742]	[0.424]	[0.662]	[1.127]	[0.729]	[0.471]	[2.310]	[0.642]	[0.603]	[0.810]	[0.753]	[0.993]	[0.486]	[0.410]	[0.624]	[0.403]	[0.276]	[0.468]
Intercept		2.396	0.798**	-1.384	2.722	0.223	-0.412	7.797	1.572	2.827	4.606	11.311	0.373	0.458	4.706	1.535	2.863	4.357	2.486	2.391**	2.037***	2.624	1.531
		[8.027]	[0.383]	[18.218]	[8.029]	[0.625]	[3.870]	[9.402]	[2.775]	[2.843]	[3.181]	[12.626]	[4.887]	[4.052]	[4.967]	[1.171]	[2.121]	[5.269]	[1.972]	[1.034]	[0.538]	[1.950]	[1.342]
Total number of countries	22																						
Total number of obs.	554																						

Table 3.9.2 The Long-and Short-Run Effects of the Components of Government Expenditures on Economic Growth: Country Specific Coefficients [2]

Variables	All
Long-run coef.	
Transport and communications	-0.669***
	[0.192]
Energy	0.056
	[0.130]
Education	3.956***
	[1.080]
Health	-0.990**
	[0.407]
GG consump exp / Total exp	-14.746***
	[3.828]
Initial GDP per cap	-5.506***
	[1.482]
Investment	2.398***
	[0.928]
Inflation	-1.293***
	[0.382]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	Latin America							East Asia						Europe								
	Argentina	Bolivia	Brazil	Chile	Colombia	Mexico	Peru	Indonesia	Korea, Rep	Malaysia	Philippines	Singapore	Thailand	Austria	Denmark	France	Germany	Netherlands	Norway	Sweden	Switzerland	United Kingdom
Error-Correction coef.	-0.290*	0.078	-0.01	-2.524***	-0.057	-0.806**	-0.780**	-1.132**	-0.058	-0.139	0.58	-1.083***	-0.511*	-0.758***	-0.273	-0.865***	-0.618**	-1.380**	-0.425*	-0.292**	-0.083	-0.133
(Phi)	[0.162]	[0.135]	[0.109]	[0.750]	[0.051]	[0.355]	[0.385]	[0.516]	[0.115]	[0.344]	[0.704]	[0.380]	[0.276]	[0.264]	[0.173]	[0.321]	[0.314]	[0.600]	[0.240]	[0.131]	[0.080]	[0.445]
Short-run coef.																						
Δ Transport & com	5.288	0.281	-1.892	-2.097***	-2.569**	2.689***	3.936**	0.835	-0.786	0.878	5.886	0.105	5.008	3.609	-0.503	7.395***	2.076	-4.082	-0.218	-0.669	-2.397	0.442
	[4.558]	[0.737]	[2.051]	[0.320]	[1.067]	[0.731]	[1.867]	[2.434]	[0.791]	[1.611]	[5.014]	[0.845]	[3.264]	[3.178]	[1.725]	[2.087]	[3.864]	[4.415]	[2.550]	[0.929]	[3.540]	[2.438]
Δ Energy	-1.708	0.221	0.205	2.929***	-0.263	0.119	-1.227*	-1.952**	0.482	0.531	-8.429***	-0.288	0.413	0.515	0.509*	3.780***	-0.304	-0.654	0.479	-0.294	-2.300***	-0.08
	[1.827]	[0.188]	[0.641]	[0.802]	[0.610]	[0.814]	[0.672]	[0.924]	[0.517]	[0.794]	[3.048]	[0.841]	[0.714]	[0.338]	[0.295]	[1.062]	[1.061]	[1.246]	[0.495]	[0.484]	[0.657]	[0.265]
Δ Education	1.571	0.66	2.45	25.183***	1.114	8.164**	18.342***	15.684***	6.355*	-11.641*	-14.441	-3.221	-14.12	-1.83	0.77	-31.935***	-10.357*	9.777**	5.735	-2.35	-8.131	-2.015
	[1.826]	[1.181]	[6.610]	[3.569]	[1.920]	[3.792]	[5.307]	[5.381]	[3.793]	[6.520]	[12.651]	[3.153]	[12.146]	[3.625]	[5.807]	[9.922]	[6.116]	[4.787]	[4.116]	[2.201]	[8.583]	[3.402]
Δ Health	5.995*	-0.955**	5.245	-8.706***	-0.302	-1.503***	-1.507	-11.399***	1.527	4.06	4.612	0.391	11.779*	-9.723*	1.182	1.707	14.571**	5.427	-1.859	3.358**	-1.622	6.216
	[3.066]	[0.445]	[4.243]	[2.202]	[1.256]	[0.560]	[4.476]	[4.013]	[1.691]	[5.699]	[7.006]	[3.235]	[6.256]	[5.482]	[4.452]	[2.113]	[6.290]	[9.278]	[4.501]	[1.430]	[1.483]	[9.011]
Δ GG consump exp / Total exp	-2.835	-0.705	-6.249	-31.112***	-1.041	-2.944	-16.813*	-10.077	-29.355***	-7.153	-9.658	-21.572***	-6.8	7.54	-29.130***	-2.865	-25.922**	-41.917**	-24.224***	-24.035***	1.292	-15.958
	[2.087]	[8.449]	[7.050]	[4.738]	[2.952]	[8.047]	[10.172]	[7.428]	[7.601]	[5.787]	[21.681]	[5.210]	[10.805]	[6.931]	[11.078]	[13.579]	[12.340]	[16.343]	[6.222]	[5.858]	[1.774]	[13.216]
Δ Initial GDP per cap	-70.243***	-85.498***	-96.702***	99.254	-24.399	-5.903	10.907	12.727	-81.069***	-96.948***	-155.132*	-5.32	-38.969	-46.636*	-89.604***	15.101	-21.257	9.067	-23.085	-76.229***	-92.480***	-66.224**
	[19.040]	[31.491]	[19.105]	[72.066]	[26.023]	[32.594]	[36.101]	[48.349]	[12.799]	[35.222]	[84.772]	[39.659]	[28.062]	[26.676]	[17.091]	[43.217]	[30.738]	[52.112]	[26.067]	[15.566]	[11.132]	[33.356]
Δ Investment	29.536***	-0.605	21.591***	20.320***	2.832	24.251***	9.229**	6.515*	24.523***	12.171***	63.859***	25.118***	19.419***	29.787***	17.158***	10.793***	33.438***	17.652**	8.153***	17.003***	22.886***	18.901***
	[6.735]	[0.951]	[4.450]	[1.290]	[2.017]	[3.237]	[4.551]	[3.481]	[3.800]	[3.531]	[13.418]	[4.941]	[4.667]	[4.492]	[3.247]	[3.179]	[5.052]	[6.930]	[2.727]	[2.114]	[3.502]	[4.822]
Δ Inflation	-1.374**	0.263	-0.856*	-3.800***	-1.121	-2.420***	-1.013	-2.494*	-0.498	0.093	3.341	0.748	-1.253*	-1.322*	0.509	-3.210**	-0.605	-0.111	-0.761	-0.235	0.233	-0.355
	[0.575]	[0.309]	[0.499]	[0.471]	[2.021]	[0.625]	[0.700]	[1.310]	[0.715]	[0.577]	[2.630]	[0.517]	[0.647]	[0.719]	[0.752]	[1.266]	[0.484]	[0.342]	[0.539]	[0.328]	[0.299]	[0.485]
Intercept	22.733**	-4.827	1.292	198.118***	4.522	60.330***	56.170**	79.231***	9.44	15.048	-38.4	87.273***	39.424**	69.296***	27.122*	80.130***	56.945**	126.526***	40.056**	29.096***	8.841	13.672
	[11.210]	[9.636]	[9.016]	[23.498]	[3.815]	[20.896]	[22.948]	[29.612]	[8.589]	[25.581]	[48.694]	[20.508]	[17.261]	[15.594]	[14.558]	[20.272]	[24.341]	[42.140]	[19.045]	[9.833]	[6.966]	[39.916]
Total number of countries	22																					
Total number of obs.	554																					

Table 3.9.3 The Long-and Short-Run Effects of the Components of Government Expenditures on Economic Growth: Country Specific Coefficients [3]

Variables	All
Long-run coef.	
Transport and communications	-0.943***
	[0.213]
Energy	0.906***
	[0.194]
Education	1.239***
	[0.297]
Health	0.442***
	[0.149]
GG consump exp / Total exp	-8.536***
	[1.732]
Initial GDP per cap	-4.641***
	[0.942]
Investment	-1.621***
	[0.466]
Inflation	-0.408***
	[0.087]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
				Latin America						East Asia								Europe				
	Argentina	Bolivia	Brazil	Chile	Colombia	Mexico	Peru	Indonesia	Korea, Rep	Malaysia	Philippines	Singapore	Thailand	Austria	Denmark	France	Germany	Netherlanc	Norway	Sweden	Switzerlan	United Kingdom
Error-Correction coef.	-4.370***	0.890***	-0.225	-2.991***	-0.103	-0.304*	-1.654***	-0.457	-0.074	0.159	-9.896***	-0.23	-0.28	-0.780**	-0.265	0.958**	-0.383	-1.557**	-0.078	-0.173**	-0.117	-0.125
(Phi)	[0.895]	[0.192]	[0.240]	[0.670]	[0.089]	[0.177]	[0.610]	[0.393]	[0.117]	[0.247]	[3.676]	[0.164]	[0.195]	[0.327]	[0.177]	[0.375]	[0.257]	[0.657]	[0.321]	[0.085]	[0.299]	[0.316]
Short-run coef.																						
Δ Transport & com	8.979***	3.402***	-0.667	-1.716***	-2.691***	3.241***	6.274***	0.486	-0.757	0.596	0.889	0.202	7.500**	8.508***	-0.041	1.552	4.389	5.208*	3.01	0.537	-2.901	-0.141
	[1.964]	[0.332]	[1.775]	[0.452]	[0.907]	[0.789]	[1.681]	[2.523]	[0.975]	[1.747]	[3.260]	[1.436]	[3.776]	[3.024]	[1.804]	[1.778]	[4.150]	[3.088]	[2.591]	[1.180]	[3.649]	[2.182]
Δ Energy	2.626***	-0.553***	0.125	0.044	-0.048	0.981	-0.724	-1.456	0.908	0.375	0.907	-1.462	0.273	0.483	0.604**	-1.131	-1.052	0.05	0.536	0.484	-2.051***	0.165
	[0.562]	[0.099]	[0.617]	[1.088]	[0.513]	[0.788]	[0.650]	[1.062]	[0.608]	[0.852]	[3.176]	[1.187]	[0.732]	[0.347]	[0.296]	[0.872]	[1.240]	[1.379]	[0.518]	[0.583]	[0.738]	[0.321]
Δ Education	2.392***	1.842***	3.127	20.267***	2.616	6.913**	12.546***	13.010**	4.731	-15.118**	-70.333***	-6.094	-14.18	16.619**	2.91	-1.386	-4.957	0.865	4.781	-1.569	1.153	-0.786
	[0.606]	[0.319]	[6.294]	[4.291]	[1.686]	[3.102]	[4.702]	[5.511]	[4.696]	[6.862]	[16.089]	[4.319]	[11.999]	[7.503]	[6.012]	[6.692]	[10.664]	[3.635]	[4.162]	[2.476]	[11.483]	[2.603]
Δ Health	11.275***	-2.652***	3.938	3.742	-0.779	-1.077*	-2.481	-10.030**	0.6	2.324	20.044***	1.966	13.069**	9.257	1.883	-0.908	13.586	-3.575	-0.657	2.596	1.517	4.853
	[1.183]	[0.179]	[3.783]	[3.601]	[0.825]	[0.619]	[4.185]	[4.350]	[1.994]	[5.670]	[5.668]	[4.458]	[6.370]	[6.252]	[4.533]	[2.189]	[8.549]	[6.752]	[4.705]	[1.655]	[4.290]	[9.079]
Δ GG consump exp / Total exp	-39.388***	0.931	-7.991*	-39.984***	-3.799***	0.268	-7.281	-10.405	-7.896	1.666	-35.643*	-7.696	-8.187	-68.259***	-26.083***	-36.600***	-13.571	-22.435***	-22.227***	-20.757***	-10.08	-15.988
	[3.837]	[0.808]	[4.408]	[5.079]	[1.184]	[2.865]	[4.893]	[8.486]	[6.758]	[6.029]	[20.928]	[4.812]	[5.672]	[21.397]	[9.702]	[8.373]	[18.972]	[6.331]	[6.112]	[5.691]	[18.597]	[12.525]
Δ Initial GDP per cap	318.947***	-175.689**	-77.191***	163.991**	-35.245**	-48.412***	96.061*	-46.739	-77.599***	-121.031**	980.139**	-45.514*	-64.627***	-33.144	-94.201***	-215.980**	-43.709*	56.99	-50.09	-93.589***	-91.506***	-73.957**
	[88.869]	[21.010]	[28.825]	[64.957]	[17.528]	[16.204]	[58.035]	[37.905]	[14.624]	[26.911]	[391.857]	[25.611]	[20.489]	[32.695]	[17.937]	[41.994]	[26.245]	[63.438]	[38.880]	[14.036]	[32.589]	[35.678]
Δ Investment	25.637***	-3.000***	22.815***	13.969***	1.875	25.795***	7.289*	5.202	28.923***	11.383***	12.966	31.969***	18.677***	19.564***	19.529***	16.259***	39.188***	14.447**	7.844***	16.089***	22.913***	19.379***
	[3.324]	[0.353]	[4.251]	[1.531]	[1.583]	[3.618]	[4.182]	[3.689]	[4.215]	[3.307]	[14.706]	[6.400]	[4.736]	[4.949]	[2.684]	[3.342]	[4.491]	[6.585]	[2.945]	[2.401]	[3.582]	[4.296]
Δ Inflation	-1.055***	0.529***	-0.098	-3.160***	-0.85	-2.172***	-2.117***	-0.606	-1.462*	0.331	-11.589***	0.937	-1.208*	-0.899	0.868	0.395	-0.721	-0.342	-0.72	0.234	0.165	-0.133
	[0.200]	[0.068]	[0.604]	[0.619]	[1.400]	[0.483]	[0.745]	[1.207]	[0.806]	[0.508]	[4.243]	[0.656]	[0.679]	[0.694]	[0.757]	[0.905]	[0.573]	[0.351]	[0.559]	[0.356]	[0.311]	[0.461]
Intercept	325.936***	-62.167***	17.997	219.771***	7.512	23.247*	115.921***	34.471	10.159	-7.164	677.631***	21.221*	23.415*	71.795***	25.266*	-76.704***	34.259	136.552***	8.317	16.655***	11.445	12.34
	[21.588]	[5.707]	[18.114]	[24.508]	[6.159]	[12.251]	[35.867]	[26.675]	[8.720]	[18.106]	[206.956]	[12.804]	[13.324]	[25.498]	[14.613]	[27.116]	[20.920]	[50.182]	[27.489]	[6.381]	[25.511]	[26.277]
Total number of countries	22																					
Total number of obs.	554																					

Table 3.9.4 The Long-and Short-Run Effects of the Components of Government Expenditures on Economic Growth: Country Specific Coefficients [4]

Variables	All
Long-run coef.	
Transport and communications	-0.943***
	[0.213]
Energy	0.906***
	[0.194]
Education	1.239***
	[0.297]
Health	0.442***
	[0.149]
GG consump exp / Total exp	-6.893***
	[1.379]
Initial GDP per cap	-4.641***
	[0.942]
Investment	-1.621***
	[0.466]
Inflation	-0.408***
	[0.087]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	20	22
				Latin America						East Asia								Europe				
	Argentina	Bolivia	Brazil	Chile	Colombia	Mexico	Peru	Indonesia	Korea, Rep	Malaysia	Philippines	Singapore	Thailand	Austria	Denmark	France	Germany	Netherlanc	Norway	Sweden	Switzerlan	United Kingdom
Error-Correction coef.	-4.370***	0.890***	-0.225	-2.991***	-0.103	-0.304*	-1.654***	-0.457	-0.074	0.159	-9.896***	-0.23	-0.28	-0.780**	-0.265	0.958**	-0.383	-1.557**	-0.078	-0.173**	-0.117	-0.125
(Phi)	[0.895]	[0.192]	[0.240]	[0.670]	[0.089]	[0.177]	[0.610]	[0.393]	[0.117]	[0.247]	[3.676]	[0.164]	[0.195]	[0.327]	[0.177]	[0.375]	[0.257]	[0.657]	[0.321]	[0.085]	[0.299]	[0.316]
Short-run coef.																						
Δ Transport & com	8.979***	3.402***	-0.667	-1.716***	-2.691***	3.241***	6.274***	0.486	-0.757	0.596	0.889	0.202	7.500**	8.508***	-0.041	1.552	4.389	5.208*	3.01	0.537	-2.901	-0.141
	[1.964]	[0.332]	[1.775]	[0.452]	[0.907]	[0.789]	[1.681]	[2.523]	[0.975]	[1.747]	[3.260]	[1.436]	[3.776]	[3.024]	[1.804]	[1.778]	[4.150]	[3.088]	[2.591]	[1.180]	[3.649]	[2.182]
Δ Energy	2.626***	-0.553***	0.125	0.044	-0.048	0.981	-0.724	-1.456	0.908	0.375	0.907	-1.462	0.273	0.483	0.604**	-1.131	-1.052	0.05	0.536	0.484	-2.051***	0.165
	[0.562]	[0.099]	[0.617]	[1.088]	[0.513]	[0.788]	[0.650]	[1.062]	[0.608]	[0.852]	[3.176]	[1.187]	[0.732]	[0.347]	[0.296]	[0.872]	[1.240]	[1.379]	[0.518]	[0.583]	[0.738]	[0.321]
Δ Education	2.392***	1.842***	3.127	20.267***	2.616	6.913**	12.546***	13.010**	4.731	-15.118**	-70.333***	-6.094	-14.18	16.619**	2.91	-1.386	-4.957	0.865	4.781	-1.569	1.153	-0.786
	[0.606]	[0.319]	[6.294]	[4.291]	[1.686]	[3.102]	[4.702]	[5.511]	[4.696]	[6.862]	[16.089]	[4.319]	[11.999]	[7.503]	[6.013]	[6.692]	[10.664]	[3.635]	[4.162]	[2.476]	[11.483]	[2.603]
Δ Health	11.275***	-2.652***	3.938	3.742	-0.779	-1.077*	-2.481	-10.030**	0.6	2.324	20.043***	1.966	13.069**	9.257	1.883	-0.908	13.586	-3.575	-0.657	2.596	1.517	4.853
	[1.183]	[0.179]	[3.783]	[3.601]	[0.825]	[0.619]	[4.185]	[4.350]	[1.994]	[5.670]	[5.668]	[4.458]	[6.370]	[6.252]	[4.533]	[2.189]	[8.549]	[6.752]	[4.705]	[1.655]	[4.290]	[9.079]
Δ GG consump exp / Total exp	-14.116***	2.971***	-1.467	-17.648***	-4.701**	10.327***	8.334	-8.395	-2.414	-10.157***	-84.136***	-13.084***	-1.524	-33.393***	-20.727***	-38.474***	-1.605	-19.887***	-14.556**	-18.709***	-10.08	-15.988
	[2.352]	[0.767]	[7.419]	[3.039]	[1.857]	[3.958]	[8.864]	[6.834]	[6.248]	[3.299]	[30.044]	[4.448]	[8.601]	[12.721]	[6.694]	[7.939]	[6.306]	[5.897]	[6.244]	[4.551]	[18.597]	[12.525]
Δ Initial GDP per cap	318.943***	-175.688**	-77.191***	163.988**	-35.245**	-48.412***	96.060*	-46.74	-77.599***	-121.031**	980.122**	-45.514*	-64.627***	-33.144	-94.201***	-215.980**	-43.709*	56.988	-50.09	-93.589***	-91.506***	-73.957**
	[88.870]	[21.010]	[28.825]	[64.957]	[17.528]	[16.204]	[58.035]	[37.905]	[14.624]	[26.911]	[391.856]	[25.611]	[20.489]	[32.695]	[17.937]	[41.994]	[26.245]	[63.438]	[38.880]	[14.036]	[32.589]	[35.678]
Δ Investment	25.637***	-3.000***	22.815***	13.969***	1.875	25.795***	7.289*	5.202	28.923***	11.383***	12.966	31.969***	18.677***	19.564***	19.529***	16.259***	39.188***	14.447**	7.844***	16.089***	22.913***	19.379***
	[3.324]	[0.353]	[4.251]	[1.531]	[1.583]	[3.618]	[4.182]	[3.689]	[4.215]	[3.307]	[14.706]	[6.400]	[4.736]	[4.949]	[2.684]	[3.342]	[4.491]	[6.585]	[2.945]	[2.401]	[3.582]	[4.296]
Δ Inflation	-1.055***	0.529***	-0.098	-3.160***	-0.85	-2.172***	-2.117***	-0.606	-1.462*	0.331	-11.589***	0.937	-1.208*	-0.899	0.868	0.395	-0.721	-0.342	-0.72	0.234	0.165	-0.133
	[0.200]	[0.068]	[0.604]	[0.619]	[1.400]	[0.483]	[0.745]	[1.207]	[0.806]	[0.508]	[4.243]	[0.656]	[0.679]	[0.694]	[0.757]	[0.905]	[0.573]	[0.351]	[0.559]	[0.356]	[0.311]	[0.461]
Intercept	292.854***	-55.431***	16.29	197.125***	6.736	20.942*	103.398***	31.013	9.597	-5.96	602.709***	19.480*	21.297*	65.890***	23.258*	-69.449***	31.36	124.766***	7.727	15.345***	11.445	12.34
	[20.534]	[5.590]	[16.340]	[21.385]	[5.510]	[11.002]	[32.137]	[23.799]	[7.842]	[16.252]	[183.869]	[11.617]	[11.901]	[23.265]	[13.347]	[24.592]	[19.077]	[46.139]	[25.065]	[5.805]	[25.511]	[26.277]
Total number of countries	22																					
Total number of obs.	554																					

Table 3.10.1 Long-and Short-Run Effects of the Components of Government Expenditure on Economic Growth by Alternative Pooled Estimators [2]

Model specification: [2] 4 exp (% of GDP), gg consump exp (% of GDP), and control variables (initial GDP, investment, and inflation).

	[1] PMG estimators		[2] MG estimators		[3] DFE estimators	
Variables	Coef.	Std. error	Coef.	Std. error	Coef.	Std. error
Long-run coef.						
Transport and communications	-0.669***	[0.192]	-1.864	[1.272]	1.541	[3.318]
Energy	0.056	[0.130]	-5.453	[5.068]	-0.268	[0.500]
Education	3.956***	[1.080]	0.996	[1.120]	-1.709	[3.009]
Health	-0.990**	[0.407]	-13.17	[13.196]	1.245	[2.481]
GG consump exp / Total exp	-14.746***	[3.828]	1.825	[2.513]	6.013	[11.144]
Initial GDP per cap	-5.506***	[1.482]	2.221	[2.170]	4.242	[7.875]
Investment	2.398***	[0.928]	22.357	[26.692]	-5.419	[10.873]
Inflation	-1.293***	[0.382]	10.346	[9.873]	1.642	[3.02]
Error-Correction coef. (Phi)	-0.525***	[0.137]	-24.854	[26.843]	0.541	[1.016]
Short-run coef.						
Δ Transport & com	1.055	[0.655]	2.404	[2.127]	-0.175	[0.976]
Δ Energy	-0.332	[0.482]	-0.996	[0.723]	0.072	[0.173]
Δ Education	-0.192	[2.641]	-18.19	[17.130]	1.371	[1.303]
Δ Health	1.295	[1.327]	7.144	[6.735]	-0.705	[0.715]
Δ GG consump exp / Total exp	-13.706***	[2.775]	-29.497**	[14.572]	-4.459	[1.898]
Δ Initial GDP per cap	-42.211***	[11.861]	2,429.50	[2,745.899]	-152.931	[100.526]
Δ Investment	19.751***	[2.827]	8.989	[12.252]	17.654***	[2.715]
Δ Inflation	-0.738**	[0.317]	-0.646	[1.762]	-1.063***	[0.383]
Intercept	44.638***	[10.805]	96.448	[76.660]	24.219***	[8.461]
No. of countries	22		22		22	
No. of obs.	554		554		554	

Notes: *The model is estimated by the pooled mean group, mean group, and dynamic fixed effect estimators, respectively.*
The dependent variable is per capita real growth rate of GDP.
Model specification: ARDL(1,1,1,1,1,1,1,1,1)

Table 3.10.2 Long-and Short-Run Effects of the Components of Government Expenditure on Economic Growth by Alternative Pooled Estimators [3]

Model specification: [3] 4 exp (% of GDP), total exp (% of GDP), and control variables (initial GDP, investment, inflation).

	[1] PMG estimators		[2] MG estimators		[3] DFE estimators	
Variables	Coef.	Std. error	Coef.	Std. error	Coef.	Std. error
Long-run coef.						
Transport and communications	-0.943***	[0.213]	-0.623	[0.769]	0.873	[1.185]
Energy	0.906***	[0.194]	-5.552	[5.084]	-0.155	[0.275]
Education	1.239***	[0.297]	-1.847	[1.700]	-0.928	[1.572]
Health	0.442***	[0.149]	-8.791	[14.162]	0.634	[0.952]
GG consump exp / Total exp	-8.536***	[1.732]	-4.64	[4.909]	4.451	[5.558]
Initial GDP per cap	-4.641***	[0.942]	-2.564	[5.554]	2.686	[3.334]
Investment	-1.621***	[0.466]	26.384	[26.282]	-2.974	[3.769]
Inflation	-0.408***	[0.087]	9.595	[9.911]	1.071	[1.271]
Error-Correction coef. (Phi)	-1.002**	[0.493]	-16.066	[20.560]	0.706	[0.852]
Short-run coef.						
Δ Transport & com	2.085***	[0.742]	-2.124	[4.474]	0.257	[0.451]
Δ Energy	0.004	[0.221]	-6.161	[3.913]	0.065	[0.203]
Δ Education	-0.939	[3.770]	-12.207	[16.464]	2.230**	[1.046]
Δ Health	3.113**	[1.443]	2.531	[6.723]	-0.360	[0.642]
Δ GG consump exp / Total exp	-18.246***	[3.657]	-32.734	[27.825]	-7.702***	[1.374]
Δ Initial GDP per cap	10.359	[52.069]	1,471.45	[2,073.132]	-169.091**	[85.203]
Δ Investment	17.214***	[2.137]	3.23	[21.795]	16.884***	[1.114]
Δ Inflation	-1.076**	[0.547]	1.556	[3.257]	-0.950***	[0.179]
Intercept	74.903**	[34.282]	205.344	[289.134]	25.123***	[5.834]
No. of countries	22		22		22	
No. of obs.	554		554		554	

Notes: *The model is estimated by the pooled mean group, mean group, and dynamic fixed effect estimators, respectively.*
The dependent variable is per capita real growth rate of GDP.
Model specification: ARDL(1,1,1,1,1,1,1,1,1)

Table 3.10.3 Long-and Short-Run Effects of the Components of Government Expenditure on Economic Growth by Alternative Pooled Estimators [4]

Model specification: [4] 4 exp (% of total exp), total exp (% of GDP), and control variables (initial GDP, investment, inflation).

	[1] PMG estimators		[2] MG estimators		[3] DFE estimators	
Variables	Coef.	Std. error	Coef.	Std. error	Coef.	Std. error
Long-run coef.						
Transport and communications	-0.943***	[0.213]	-0.026	[0.401]	0.873	[1.185]
Energy	0.906***	[0.194]	-3.152	[2.716]	-0.155	[0.275]
Education	1.239***	[0.297]	-1.847	[1.700]	-0.928	[1.572]
Health	0.442***	[0.149]	-0.999	[7.283]	0.634	[0.952]
GG consump exp / Total exp	-6.893***	[1.379]	-2.571	[2.124]	4.875	[6.030]
Initial GDP per cap	-4.641***	[0.942]	-1.911	[5.757]	2.686	[3.334]
Investment	-1.621***	[0.466]	12.032	[11.940]	-2.974	[3.769]
Inflation	-0.408***	[0.087]	2.959	[3.281]	1.071	[1.271]
Error-Correction coef. (Phi)	-1.002**	[0.493]	-16.052	[20.562]	0.706	[0.852]
Short-run coef.						
Δ Transport & com	2.085***	[0.742]	-2.276	[4.461]	0.257	[0.451]
Δ Energy	0.004	[0.221]	-5.659	[3.939]	0.065	[0.203]
Δ Education	-0.939	[3.770]	-14.228	[16.714]	2.230	[1.047]
Δ Health	3.113**	[1.443]	2.745	[6.843]	-0.360	[0.642]
Δ GG consump exp / Total exp	-13.983***	[4.195]	-52.792	[48.492]	-5.509***	[1.365]
Δ Initial GDP per cap	10.358	[52.068]	1,471.55	[2,073.231]	-169.091**	[85.203]
Δ Investment	17.214***	[2.137]	1.603	[21.880]	16.884***	[1.114]
Δ Inflation	-1.076**	[0.547]	1.489	[3.281]	-0.950***	[0.179]
Intercept	67.314**	[30.558]	404.733**	[202.798]	26.510***	[6.125]
No. of countries	22		22		22	
No. of obs.	554		554		554	

Notes: *The model is estimated by the pooled mean group, mean group, and dynamic fixed effect estimators, respectively.*
The dependent variable is per capita real growth rate of GDP.
Model specification: ARDL(1,1,1,1,1,1,1,1,1)

Chapter 4: Conclusion

In my dissertation, I investigated two key questions related to the relationship between government spending and economic performance: how does the relationship change when government size increases and what is the growth enhancing level of government spending, and what are the impacts of different types of government spending on real economic activity and how do they change in the short-and long-run?.

This research topic has important information for anticipating the speed and sustainability of the recovery process, as well as growth path of the economy. Achieving a more efficient allocation of government resources would not only speed the recovery but also improve the economy's long-term performance.

The first essay explores a nonlinear relationship between government spending and macroeconomic performance on time series data of five OECD countries from 1970-2008 using the Hansen threshold model. The result suggest that there is strong evidence of the existence of a "turning point" in the relationship between the level of government spending and real economic activity and that of an optimal size for government spending. In addition, the impact of government investment on real GDP growth has a quite different pattern than that for government consumption. That is, government investment has a positive impact below the threshold and its impact dissipates or becomes zero above the threshold, but there is little support of positive impact of consumption expenditure found except for Japan. These results have critical policy implications. First, in the case of the U.S., the misallocation of resources arising from ineffective pattern of expenditure across

the different components of government spending was detected. In other words, the government spent less than the threshold value on consumption expenditure, but overspent on government investment slightly and total government expenditure quite a lot in the fourth quarter of 2008. Given the fact that the U.S. real GDP growth rate has been gradually falling after reaching its peak in the mid-1980s, a more efficient resource allocations including transferring the resources to the private sector could improve the long-term economic performance.

Second, the results for Japan are quite different from other four countries. Unlike other countries, consumption expenditure has a positive impact below and above the threshold value in Japan. In addition, Japan's estimated threshold value for government investment is the highest among five countries, and the impact of investment on real GDP growth is positive above the threshold value and negative below it, while the opposite pattern happens in other countries. These results suggest that each country's fiscal experience determines the nature of the relationship between government spending and macroeconomic performance and thereby country-specific conditions and institutions are critical factors to influence it.

The second essay investigates the impacts of different components of government spending on economic activity on a panel dataset including Latin American, East Asian, and European countries for the 1970-2006 period. The pooled ARDL error-correction model estimates both the short-and long-run effects of government spending on growth through the PMG estimator. The results show that expansionary fiscal policy on infrastructure spending appears to be effective in the short-run, but it does not necessarily

mean that it also spurs the long-run economic growth. The long-run effect of energy spending is positive while that of transport and communications is negative. In addition, social spending appears to have positive long-run impact on growth. The results also show that government spending on education starts generating positive returns to growth in the long-run. As for health spending, the short-run impacts are positive as long as an increase in the share of health spending is adjusted by a decrease in other spending shares. Finally, increasing government consumption expenditure is associated with negative economic growth in both the short-and long-run.

Some important policy implications are drawn from these findings. First, compositional effects are crucial in maximizing the effectiveness of government resources. The design of fiscal policy should take both the composition of government spending as well as their impacts at different time horizons into consideration.

Second, the usefulness of discretionary fiscal policy is not clear at least for short-run stabilization purposes. The effect of government consumption on economic activity is found to be strongly negative in the short-run, while that of infrastructure spending is strongly positive. The effectiveness of fiscal policy should depend on the components of government spending.

Lastly, it is critical for a government to create fiscal space for various components of government spending including energy, education, and health which are likely to have positive impacts on economic performance and pay for themselves over the medium and long-term.

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Appendices

Chapter 2

Appendix 2.1: Alternative Functional Forms: Quadratic and Cubic Function Models

As the true functional form is unknown, I estimated alternative function models so that the optimal government size is compared to that from the threshold model.

At first, I estimated a quadratic model for each measure of government spending using data for the U.S. When the linear and quadratic terms in the quadratic model were not statistically significant, then I estimated the cubic function model to check if the cubic model fits the data better. The quadratic model is similar to Eq. (8), but instead of the government spending growth multiplied by government size variable, it has linear and squared terms of government size which is defined as government spending as a ratio to GDP.

The expected sign of the linear term is positive, which shows the beneficial effects of government spending on real GDP growth, while that of the squared term is negative, which captures any adverse effects associated with increased government size. Since the squared term increases in value faster than the linear term, the negative effects from government spending eventually offsets the positive effects, producing the downward-sloping portion. In other words, the positive and negative signs of the linear and squared terms confirm the peak. The results from three measures of government spending are the following:

First, the estimated result using government consumption illustrates that the

coefficient of the linear term was positive, and that of quadratic term was negative, as predicted. Both coefficients were significant at the 5 percent level. The optimal government size was 18.4 percent which was smaller than the threshold value of 19.6 percent from the threshold model by about 1 percent of GDP.

Second, the result using government investment shows that the coefficient of linear term was positive, and that of the quadratic term was negative, but none of them was statistically significant. The optimal government size was 3.2 percent, which was slightly larger than the threshold value of 3.0 percent obtained through the threshold model. As neither of the coefficients was found statistically significant, I also estimated the cubic model. The result indicates that the sign of the coefficients of linear, quadratic, and cubic terms was negative, positive, and positive, respectively, and none of them was statistically significant.

Lastly, similar with the case of government investment, the result using total government expenditure presented that both linear and quadratic terms had the right sign but none of the coefficients was statistically significant. The optimal government size was 31.1 percent which was much smaller than the threshold values of 35.5 and 36.0 percent found by the threshold model. To check the appropriate functional form that fits the data better, I estimated the cubic model. The result shows that the sign of the coefficients of linear, quadratic, and cubic terms was negative, positive, and positive, and all were significant at the 1 percent level. The optimal government size obtained was 35.5 percent which was very similar to the first threshold value.

To conclude, the findings suggest that the optimal government size obtained by

alternative functional forms is similar to the threshold value in some cases, but different in other. In addition, the appropriate functional form depends on the measure of government spending.

Appendix 2.2: Calculating the Percentiles of Threshold Value

Hansen (1999) suggested restricting the search in the threshold value of the threshold variable so that a minimum percentage of the observations (1 or 5 percent) lies in each regime. On the other hand, Hansen (1996) and Lee and Chen (2005) set the threshold variable observations to sit between 15 and 85 percentile as suggested by Andrew (1993). In order to make sure that a minimal set of observations is included in both below and above the threshold (also in each threshold regime), I set the threshold variable to be found between 15 and 85 percentile of its value.

The method on how to restrict the threshold variable is shown using the U.S. government consumption as an example. First, a new variable which contains 15-85 percentile of the original value of government spending is created. Next, the percentiles of the new variable is calculated where the number of percentiles is set as 100. The percentiles listed in Tables 2.5.1 and 2.6.1 indicate that the 0.196 is 91th percentile of the government consumption variable which contains 15-85 percentile of the original value.

Appendix 2.3: Grid Search Method Algorithm

The grid search algorithm was conducted as follows:

1.) As explained above, at first, a new variable which contains 15-85 percentile of the original value of government spending is created. Then, the percentiles of the new variable is calculated where the number of percentiles is set as 100. These 100 percentiles are used as the grid steps (starting from 2nd percentile 0.148 to 99th percentile 0.120).

2.) Using each one of 100 grid steps (in fact using 2nd through 99th percentile), Eq. (12) (the threshold model) is estimated and the least squared errors is obtained. Once finished estimating the threshold model with all the grid steps, the threshold value with the minimum sum of squared errors are identified. In the case of the U.S., 91th percentile of government consumption is found to have the minimum sum of squared errors. Thereby, 0.196 (91th percentile) is the first threshold value.

Appendix 2.4: The Bootstrap Procedure

This method follows Hansen (1999 p.351, 2000 p.587). The bootstrap procedure is conducted as follows:

1.) Once the threshold value with the minimum sum of squared errors is identified, estimate the threshold model (Eq. (12)) using the threshold value and obtain the sum of squared errors ($S_1(\hat{\theta})$).

2.) Then, estimate the null model (that is, the linear model, Eq. (8)) and obtain the sum

of squared errors (S_0).

3.) Obtain the likelihood ratio test of the null, which is F_1 statistics (shown in Eq. (17)). As the F_1 distribution is non-standard and thereby cannot be used, compute p-values by using the following bootstrap procedure.

4.) Generate the bootstrap dependent variable from the distribution $N(0, \hat{e}_i^2)$ where $\hat{e}_i$ is the OLS residual from the estimated null model. In order to do that, at first, obtain the residual variance from the estimated null mode, and then create a variable which is normally distributed random numbers with mean zero and standard deviation of 1, adjusting it with the residual variance of the null. Then, use this as the bootstrap dependent variable.

5.) Generate the bootstrap dependent variable on the control variables of the null model (Eq. (8)), as well as those of threshold model (eq. (12)), and obtain the sum of squared errors $S_1(\theta_0)$ and $S_1(\hat{\theta})$, respectively. Then, calculate the likelihood ratio test statistics by using Eq. (18).

6.) Compare the simulated LR statistics to actual F_1 statistics found earlier. If LR statistics exceeds the F_1 statistics, count as 1.

7.) Repeat the procedure 1000 times and calculate the percentage of draws for which the LR statistics exceeds F_1 statistics, which is the bootstrap p-value of F_1 under the null.

Chapter 3

Appendix 3.1: Other Sources for Fiscal Data

- The World Bank Interim Report (2006): supplementary consolidated central government and general government data for selected countries are available for 1980-2005 with 5 year intervals.

- ECLAC Statistics Yearbook: public expenditures on health and education are available for LAC countries for 1970-2006.

- Asian Development Bank (ADB) Key Indicators for Asia and the Pacific 2008: public expenditures on health and education are available for EAP countries for 1990-2007.

- Calderon, Cesar, and Luis Serven (2010) "Infrastructure in Latin America," Policy Research Working Paper, No.5317, The World Bank. Infrastructure investment data are available for Latin American countries for 1981-2006.