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A disaggregated analysis of public spending and economic growth in developing and high-income countries

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ABSTRACT

In this study, the permanent growth effects of fiscal policy are investigated across countries with different income levels using the public-policy endogenous growth model, where public spending is classified by function. The endogeneity problems associated with taxes and investment are taken into account, as is a possible non-linear relationship between government expenditure and economic growth. The results have shown that gross capital formation is the only control variable that has a significant positive coefficient in all growth regressions, while the evidence of conditional convergence hypothesis is reaffirmed. An increase in transportation and communication spending is conducive to growth in both developing and high-income countries, whereas other types of spending are not.

Keywords: Fiscal Policy, Economic Growth, Public Expenditure, Government

JEL Classification: E62, H50, O23, O47

1. Introduction

Government has a role to play both in enhancing and stabilising its country's economic performance. Public expenditure is a crucial tool for undertaking these responsibilities, since it enhances the productivity of private capital. The constrained government budget might be allocated according to functional purposes suitable for different stages of economic development in any particular country. For developing countries, public infrastructure is a fundamental input, facilitating economic activities in order to essentially promote economic growth. In high-income countries, healthcare and social welfare programs are currently a substantial part of total spending as a result of commonly and intensely found problems of population ageing. Since raising revenue as to match so with increasing public expenditure seems unsustainable and impermissible; it is necessary to focus on particular functions of expenditure and re-allocate the limited resources efficiently. Hence, the relationship between economic development and public expenditure should be clearly identified and fully understood in order to achieve aforementioned reasons.

2. Literature review

2.1 Public-policy endogenous growth models

Endogenous growth models allow us to identify the effects especially of fiscal policy on long-term growth (Barro & Sala-i-Martin, 1992). There are channels through which fiscal policy could have permanent growth effects in the endogenous growth models, for example, production externalities, productivity growth, productivity differences and fiscal effects on factor accumulation, crowding-out effects, and redistribution (Gemmell, 2001). Barro's (1990)

growth model incorporates a public sector into constant-returns model of economic growth. Public services in this model is included as a productive input of private producers with an assumption that private inputs are not close substitutes for public inputs.

Long-run output growth can then be affected by both productive government expenditure and distortionary taxation as illustrated by Romero-Avila and Strauch (2008) using Barro's (1990) model. The population of consumers was normalised to one and they both consume and produce final output according to the production function:

$$y = Ak^{1-\gamma}g^{\gamma} \tag{1}$$

where *k* represents accumulated private physical capital and *g* is productive government expenditure entering production function directly. The government constraint is determined by:

$$g + G = \tau y + T \tag{2}$$

where *G* is other public spending that is not an input of the production function, *T* represents lump-sum taxation and $\boldsymbol{\tau}$ is the tax rate on output which distorts the decision to invest by private entity. Consumers maximise intertemporal utility function:

$$\int_0^{\infty} e^{-\rho t}\left[\frac{c^{1-\sigma}-1}{1-\sigma}\right]dt \tag{3}$$

where $\boldsymbol{\rho}$ represents the rate of time preference and σ is the elasticity of intertemporal substitution of consumption. In steady state, the growth rate of output and consumption is then determined by Equation (4):

$$\frac{\dot{c}}{c} = \frac{\dot{y}}{y} = \left(\frac{1}{\sigma}\right)\left\{(1-\tau)(1-\gamma)A^{\frac{1}{1-\gamma}}\left(\frac{g}{y}\right)^{\frac{\gamma}{1-\gamma}} - \rho\right\} \qquad (4)$$

The equation above is shown that productive government expenditure affects growth positively, while distortionary taxation produces negative effect on growth.

Our further empirical analyses emphasise on the potential effects of fiscal policy on long-term growth rates under the Barro's type endogenous growth model as illustrated by Romero-Avila and Strauch (2008).

2.2 Three generations of fiscal-growth studies

Gemmell (2001) argues that previous empirical studies on the relationship between fiscal policy and economic growth are regarded as unreliable. The two main reasons for unreliability are inappropriate estimation method and failure to take the role of government budget constraint into account. He has classified this set of studies into three generations.

The first generation of these studies existed before endogenous growth models of Romer (1986) and Barro (1990). The data used in these studies is limited while employing unreliable econometric techniques. The subsequent methodological developments have revealed that at least some of the issues; for example, endogeneity and non-linearity were not appropriately controlled for in these studies.

The second generation of studies have been inspired by neoclassical and/or endogenous growth models with consideration of fiscal policies. The specifications of the models in these studies did not appropriately link with theories which have inspired them. Most studies appear to

ignore the importance of government budget constraint and implicit financing of public expenditure.

The third generation studies recognise the role of government budget constraint while testing for fiscal affects; however, they need not precisely apply the government budget constraint i.e. the fiscal variables omitted from regressions in these studies may be non-neutral. The study of Miller and Russek (1997) is among the first which incorporates the government budget constraint into the growth regression.

Our analysis considers effects of fiscal policy on growth, taking into account the role of government budget constraint while omitting fiscal variables that are potentially neutral.

2.3 Some concerns in fiscal-growth studies

Government budget constraint (GBC)

Miller and Russek (1997) argue that many studies consider a number of different fiscal variables, but they do not examine the effects of these fiscal variables in a systematic way that controls the mode of financing. They found that the method of financing government expenditure plays an important role in determining the effect of that expenditure on economic growth.

As pointed out by Kneller et al. (1999), most early studies testing public-policy endogenous growth models fail to appropriately take into account the role of government budget constraint. The estimated results of those partial studies, which focus only on one side of the budget constraint, suffer from systematic bias relating to the assumption of implicit financing elements. This effect can be considered by using Equation (5).

$$GR_{it} = \beta_{0t} + \sum_{j=1}^{k} \beta_j^I I_{j,it} + \sum_{l=1}^{m} \beta_l^M M_{l,it} + u_{it} \quad (5)$$

$$GR_{it} = \beta_{0t} + \sum_{j=1}^{k} \beta_j^I I_{j,it} + \sum_{l=1}^{m-1} \beta_l^M M_{l,it} + \beta_m^M M_{m,it} + u_{it} \quad (6)$$

where growth, GR_{it}, in country i at time t is a function of conditioning variables, $I_{j,it}$ and a vector of fiscal variables $M_{l,it}$. When all elements of the government budget are included, the identity $\sum_{l=1}^{m} M_{l,it} = 0$ could be derived. One element of M which is $M_{m,it}$ must be omitted to avoid perfect collinearity. That omitted variable is the assumed compensating element within the budget constraint. Equation (6) is transformed to

$$GR_{it} = \beta_{0t} + \sum_{j=1}^{k} \beta_j^I I_{j,it} + \sum_{l=1}^{m-1} \gamma_l^M M_{l,it} + u_{it} \quad (7)$$

where $\gamma_l^M = \beta_l^M - \beta_m^M$ implies that γ_l^M depends on both β_l^M and β_m^M. The coefficient on each fiscal variable in Equation (7) is interpreted as the effect of a unit change in that particular variable offset by a unit change in the omitted variable. The category chosen to be omitted should be neutral, suggesting that $\beta_m^M = 0$. In the case that omitted variable is non-neutral, the estimates will be biased.

Apart from the inclusion of government budget constraint, there are also several concerns that should be taken into account in studying the relationship between fiscal variables and economic growth. Dealing with concerns about endogeneity and non-linearity can lessen inconsistency and biasedness of the estimations.

Endogeneity

In establishing the link between government spending and economic growth, fiscal and other economic variables evolve jointly over time and there might exist reverse causality between public spending and growth (Bose et al., 2007). In other words, this can be potentially seen as a simultaneity problem, since some control variables are influenced by the rate of growth and also influence the growth rate (Landau, 1983). Kneller et al. (1999) argue that the effects of business cycle and Wagner's law are the most possible sources of simultaneity in fiscal-growth regression.

Estimation by instrumental variables (IV) can address this endogeneity concern; however, the selection of instruments can be problematic as pointed out by Kneller et al. (1999). Different studies come up with various sets of instruments. In order to avoid the problem of instrument proliferation, Morozumi and Veiga (2016) use only one lag as an internal instrument to tackle the possible endogeneity of fiscal variables. Barro and Lee (1994) also use lagged values of explanatory variables as instruments. Romero-Avila and Strauch (2008) instrument private investment and inflation by their two lags. The instruments chosen by Bose et al. (2007) for private investment and political instability are their averages for five-years prior to the specific decade.

Hausman (1978) suggested comparing ordinary least squares (OLS) and two-stage least squares (2SLS) estimators as a formal test of endogeneity. We need to investigate whether OLS yield consistent estimates in order to use instrumental variable estimation (Davidson & MacKinnon, 1993). If residuals were not asymptotically independent of the control variables, the instrumental variable (IV) estimators would still be consistent but the OLS estimators would not be.

To test for endogeneity, the Durbin-Wu-Hausman test is based on a vector of contrasts between OLS and IV estimators. According to Davidson and MacKinnon (1993), these statistics can be computed by artificial regressions. As discussed by Baum et al. (2003), this way of using Durbin-Wu-Hausman test requires the estimation of the first-stage regression for each of the potentially endogenous variables. Then their residual series are augmented to the original model and the F-test is used to test for endogeneity. Later on, we use two-stage least squares estimation to take into account possible endogeneity in growth regression of investment and tax variables by using their one-year lag variables as instruments.

Non-linearity

There is a possibility that the relationship between public spending and growth can be non-linear. Barro (1990) has shown that growth rate increases with public spending when government is small and growth declines, if the size of government becomes large. Similarly, Devarajan et al. (1996) argue that both theory and intuition suggest that expenditure ratios and growth might have a non-linear relationship. Productive expenditures can be positively associated with growth when their shares in the budget are low but this turns negative when the share gets large. As the share keeps rising, decreasing returns to scale set in, and the relationship between the two variables turns negative.

Bayraktar and Moreno-Dodson (2015) try to capture this type of non-linearity between growth and public spending by adding additional variable to the specification. The variable added is either the squared value of total public spending or the squared term of productive public spending. Devarajan et al. (1996) add the square terms of the ratios of current and

capital expenditure to total expenditure to the equations for non-linear specification.

However, including a quadratic term may fail to detect non-linearity as suggested by Christie (2014). The main reason is that the effect might be present in the forms that could not be captured by a quadratic term. In order to test Barro's non-linear hypothesis, the non-linearity of the impact of government size on economic growth might be instead identified around the threshold level of public spending (Asimakopoulos & Karavias, 2016; Christie, 2014). Both studies have found asymmetric effects around threshold level of government spending.

Non-linearites in the functional form can be verified by using Ramsey's (1969) RESET test.

Our further analysis of this fiscal-growth study is primarily based on Bose et al. (2007) where several distinctive features were focussed. First, they focussed on a disaggregated level of government expenditure in developing countries. Second, the inclusion of conditioning variables was distinctively systematic, since they were separated into common conditioning variables in growth regression and policy variables. Thirdly, the role of government budget constraint was taken into account.

There are at least a few improvements from Bose et al. (2007) which we have extended. First, more extensive group of developing countries is included as well as considering a group of high-income countries. Second, different time periods apart from decade averages are analysed. In this way, we can implement panel data analysis by using annual data which is different from the cross-section data they have used. Thirdly, the alternative techniques for panel regression are introduced as a comparison. Especially, the instrumental estimates are implemented to solve for potential endogeneity of some of the control variables. Lastly, the non-linear impact

of public spending on growth has been investigated by including the squared terms. The regression analysis of our study includes control variables which mainly align with Bose et al. (2007). We look at the data analysis of public spending in Section 3 and the regression analysis of public expenditure and economic growth in Section 4.

3. Empirical evidence of public spending: size and composition

This section analyses the trend of public spending in groups of countries with different income levels. We measure total government expenditure and classify government spending into types. These types of government spending are categorised by the functions or objectives that government units intend to accomplish.[14] We use data from 75 countries according to the availability of fiscal data from Government Finance Statistics (GFS) and other control variables in our regression analysis.[15]

The fiscal data from GFS is subject to change in the analytical framework by the International Monetary Fund (IMF) from the GFSM 1986 to the GFSM 2001.[16] Our government revenue data is unaffected as it relies exclusively on the GFSM 2001 framework.

[14] The words 'type' and 'function' appear interchangeably in our discussion. Sometimes, it might be referred to as 'category'.
[15] The GFS data in our analysis is mainly extracted from the online database of the UK Data Service.
[16] GFSM stands for Government Finance Statistics Manual.

Table 1. List of 75 countries in our sample

	Country	Income group		Country	Income group
1	Argentina	Upper middle income	21	Malaysia	Upper middle income
2	Bangladesh	Low income	22	Mali	Low income
3	Belarus	Upper middle income	23	Mauritius	Upper middle income
4	Bhutan	Lower middle income	24	Moldova	Lower middle income
5	Bolivia	Lower middle income	25	Mongolia	Lower middle income
6	Bulgaria	Upper middle income	26	Morocco	Lower middle income
7	Burkina Faso	Low income	27	Nepal	Low income
8	Burundi	Low income	28	Pakistan	Lower middle income
9	Cameroon	Lower middle income	29	Panama	Upper middle income
10	Costa Rica	Upper middle income	30	Paraguay	Lower middle income
11	Dominican Republic	Upper middle income	31	Romania	Upper middle income
12	Egypt, Arab Rep.	Lower middle income	32	South Africa	Upper middle income
13	Ethiopia	Low income	33	Syrian Arab Republic	Lower middle income
14	Georgia	Lower middle income	34	Thailand	Upper middle income
15	India	Lower middle income	35	Tunisia	Upper middle income
16	Indonesia	Lower middle income	36	Turkey	Upper middle income
17	Iran, Islamic Rep.	Upper middle income	37	Ukraine	Lower middle income
18	Jamaica	Upper middle income			
19	Jordan	Upper middle income			
20	Lesotho	Lower middle income			

Note: The sample comprises 37 developing countries (low-income and middle-income) and 38 high-income countries (OECD and non-OECD)

Table 1. List of 75 countries in our sample (continued)

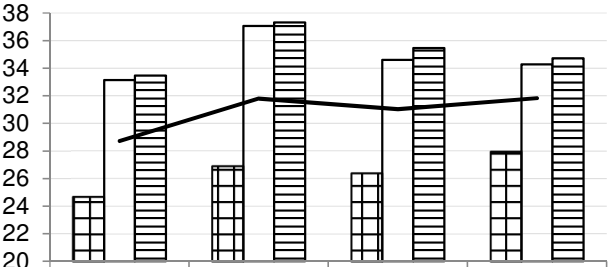
	Country	Income group		Country	Income group
38	Australia	High-income: OECD	58	New Zealand	High-income: OECD
39	Austria	High-income: OECD	59	Norway	High-income: OECD
40	Belgium	High-income: OECD	60	Poland	High-income: OECD
41	Canada	High-income: OECD	61	Portugal	High-income: OECD
42	Chile	High-income: OECD	62	Slovak Republic	High-income: OECD
43	Czech Republic	High-income: OECD	63	Slovenia	High-income: OECD
44	Denmark	High-income: OECD	64	Spain	High-income: OECD
45	Estonia	High-income: OECD	65	Sweden	High-income: OECD
46	Finland	High-income: OECD	66	Switzerland	High-income: OECD
47	France	High-income: OECD	67	United Kingdom	High-income: OECD
48	Germany	High-income: OECD	68	United States	High-income: OECD
49	Greece	High-income: OECD	69	Croatia	High-income: nonOECD
50	Hungary	High-income: OECD	70	Cyprus	High-income: nonOECD
51	Ireland	High-income: OECD	71	Latvia	High-income: nonOECD
52	Israel	High-income: OECD	72	Lithuania	High-income: nonOECD
53	Italy	High-income: OECD	73	Russian Federation	High-income: nonOECD
54	Japan	High-income: OECD	74	Trinidad and Tobago	High-income: nonOECD
55	Korea, Rep.	High-income: OECD	75	Uruguay	High-income: nonOECD
56	Luxembourg	High-income: OECD			
57	Netherlands	High-income: OECD			

Note: The sample comprises 37 developing countries (low-income and middle-income) and 38 high-income countries (OECD and non-OECD)

3.1 The size of government

To measure the size of government, the ratio of total public spending over GDP is a proxy which indicates how large a country's public sector is relative to its economy. For example, the unweighted average of total spending as a percentage of GDP between 1972 and 2012 suggests that, on average, the size of the government of countries in our sample is almost one-third (31.14%) of its economy. The size of government in high-income countries (34.82%) is higher than that of developing countries (26.63%). This may indicate that governments play relatively larger or broader roles in rich countries' economies than they do in poor ones.

Figure 1. Unweighted 10-year averages of total public spending as percentages of GDP for groups countries in our sample between 1972 and 2011



	1972-1981	1982-1991	1992-2001	2002-2011
Developing	24.64	26.86	26.35	27.90
High-income	33.14	37.07	34.61	34.27
OECD	33.46	37.33	35.47	34.72
All countries	28.71	31.80	31.04	31.83

In Figure 1, the 10-year averages of total spending indicate that the size of government seems to increase significantly from the 1970s to the 1980s. Its relative size to

GDP is lower in the 1990s, but its size in 2000s is still higher than it was in the 1970s. The increasing trend of government spending is obvious in developing countries but not in countries in other income groups. The ratio of public spending to GDP in developing countries increases from 24.64% between 1972 and 1981 to 27.90% between 2002 and 2011.

Table 2. Unweighted annual averages of public spending by type as percentages of GDP for groups of countries in our sample between 1972 and 2012

	All	**Developing**	**High-income**	**OECD**
Total spending	31.14	26.63	34.82	35.36
General public services	3.38	3.85	2.99	2.93
Defence	2.34	2.51	2.21	2.28
Transportation and communication	1.61	1.64	1.60	1.63
Education	3.29	3.43	3.17	3.24
Health	2.72	1.67	3.58	3.72
Social welfare	8.89	3.84	12.73	13.05
Other spending	8.91	9.70	8.55	8.52

Although government size in high-income countries is greater than in developing countries, this does not necessarily apply to all types of public spending by function. Table 2 shows that there are two main functions of spending in high-income countries, namely health and social welfare, which are relatively higher than in developing countries. Spending on general public services and defence in developing countries is, in contrast, higher than it is in high-income countries. The other functions of spending (transportation and communication, and education) seem to be similar

regardless of level of income across groups of countries in our sample. The ratio to GDP of each type of spending in high-income countries is very similar to that in high-income OECD countries.

3.2 The composition of public spending

The composition of public spending reveals how important each type of spending is from the perspective of the government.

Table 3. Unweighted annual averages of spending by type as percentages of total spending for groups of countries in our sample between 1972 and 2012

	All	**Developing**	**High-income**	**OECD**
General public services	11.67	15.10	8.88	8.54
Defence	8.14	9.89	6.79	6.93
Transportation and communication	5.28	6.14	4.59	4.62
Education	10.82	12.96	9.07	9.15
Health	8.41	6.32	10.11	10.40
Social welfare	26.34	13.71	35.96	36.21
Other spending	29.35	35.88	24.61	24.14

This structure could be highly dependent on a country's particular needs at its current stage of development (subject to that country's demographics). Spending on general public services (15.10%), social welfare (13.71%) and education (12.96%) are the types with the highest ratios to the total spending of developing countries. In high-income countries, social welfare (35.96%), health (10.11%) and education (9.07%) spending are the types of spending with the highest ratios to total spending. These three types of spending also

have the highest ratios to the total spending of high-income OECD countries (see Table 3).

Figure 2. Unweighted 10-year averages of public spending by type as percentages of total spending for developing countries

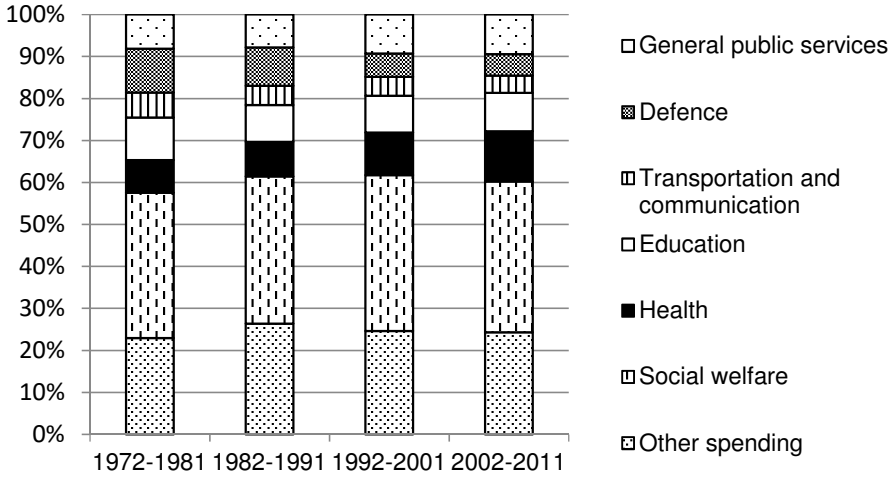
Note: Other expenditure includes all types of spending which do not fall into any of the six categories above.

As shown in Figure 2, spending on general public services and social welfare are among the highest types of spending in developing countries. Social welfare spending, in particular, has increased substantially in recent decades. In contrast, the proportions of defence, and transportation and communication spending have been decreasing. The education, health and general public services spending ratios seem to be constant over time.

In high-income countries (see Figure 3), social welfare, health and education attract some of the highest amounts of expenditure. While the ratios of spending on healthcare and general public services to total spending have increased in

recent years, the ratios of transportation and communication, and defence spending have decreased. The proportions of education and social welfare spending have remained approximately the same over time.

Figure 3. Unweighted 10-year averages of public spending by type as percentages of total spending for high-income countries



Note: Other expenditure includes all types of spending which do not fall into any of the six categories above.

4. A regression analysis of public expenditure and economic growth

In Section 3, the analysis of public expenditure data has shown that some distinct combinations of the types of government expenditure occur at different stages of economic development. For example, social welfare spending is a significant part of government expenditure in high-income countries due to ageing populations. The proportions of transportation and communication, and

education spending in the government budgets of developing countries are significantly higher than those of high-income countries in our sample. This reflects the need for investment in infrastructure and human capital in the early stages of a country's development. Since the government plays a crucial role in boosting and stabilising the economic growth of its country, it is essential to understand the link between public expenditure and economic growth at a disaggreagated level. In this section, we investigate such a link by using empirical data relating to public expenditure by function according to the IMF's definitions from the Government Finance Statistics. The main set of control variables aligns with the variables used in Bose et al.'s (2007) study.

Regression has been employed using an unbalanced panel of annual data from 1972 to 2012 for the sample of 75 countries listed in Table 1. The data has been taken from two main databases, namely Government Finance Statistics (GFS) for fiscal variables and World Development Indicators 2015 (World Bank Group, 2015) for dependent and other non-fiscal control variables.

To understand the permanent effects on growth from public expenditure, we firstly use the following five static models for the analysis: a pooled regression; a cross-section fixed effects model; a cross-section random effects model; a two-way fixed effects model; and a two-way random effects model.

Model selection methods used for static models in our study are the adjusted R^2 and the Hausman test. Using both tests shows that the two-way fixed effects model is preferred in most of the specifications. Therefore, the following analysis starts with the results of the two-way fixed effects model.

Growth regressions in previous studies have extensive sets of variables included on the right-hand side of the

equation. This study mainly includes the variables used in the framework proposed by Bose et al. (2007), which featured three sets of variables: conditioning variables (I) for growth regression; indicators (Z) for monetary policies, trade policies and market distortion; and variables of particular interest for the study (M), mainly government expenditure. The advantage of using this classification is that the typical set of conditioning variables (I) are distinctly separated from the particular set of conditioning variables (Z) for the study on the relationship between public expenditure and economic growth. We can refer these variants to our base regression (I variables) and regression as a robustness check (Z variables). The following subsections include model specification, issues of endogeneity and non-linearity, and our regression results for both developing and high-income countries.

4.1 Model specification

We begin the analysis with the standard set of control variables in base regression. Secondly, the robustness check for base regression is required in order to detect the sensitivity of the analysis. Thirdly, the government budget constraint is taken into account to avoid bias from the exclusion of important elements of fiscal variables. Lastly, we include government budget constraint together with variables for the robustness check. This final specification is expected to provide the most reliable estimates, since the biases from both omitted variables and the exclusion of government budget constraint are taken into account.

Base regression

In our base regression, independent variables are separated into two sets which are: six conditioning variables (I); and variables of particular interest (M) on public spending. The growth regression is represented by Equation (8).

$$GR_{it} = \beta_{0t} + \sum_{j=1}^{6} \beta_j^I I_{j,it} + \beta^M M_{it} + u_{it} \qquad (8)$$

There are several forms for the measurement of economic growth which could be used as the dependent variable. However, one of the most standardised forms is the growth of gross domestic product per capita in percentage terms (GR_{it}).

The per capita growth rate is generally related to two different types of conditioning variables: the initial level of state variables and the other control (environmental) variables. Morozumi and Veiga (2016) argue that, while state variables describe the initial position of the economy, the control variables determine the steady-state level of output per effective worker. In our framework of the public-policy endogenous growth model, fiscal variables also have potential impacts on the steady-state per capita growth rate. Our conditioning variables (I) include both initial levels of state variables and the other environmental variables.

In the extensions of the neoclassical and endogenous growth models, Easterly and Rebelo (1993) claim that the rate of growth is a function of two types of state variables: the initial level of physical capital and the initial level of human capital. The stock of human capital can be represented in the forms of educational attainment and health, particularly in the model of Barro and Sala-i-Martin (2004).

We therefore include initial GDP per capita, initial school enrolment rates and initial life expectancy as the proxies for state variables in this study. Initial school enrolment rates and initial life expectancy represent initial levels of human capital.

We will firstly consider initial GDP per capita. A number of studies include initial GDP per capita as a state variable. The coefficient of the initial level of per capita GDP represents the rate of convergence; that is, the responsiveness of the growth rate to a proportional change in initial GDP per capita (Barro & Sala-i-Martin, 2004; Morozumi & Veiga, 2016). Barro and Lee (1994) argue that this state variable captures a conditional convergence effect, whereby a country grows faster if it begins at lower real per capita GDP relative to its initial level of human capital. This effect is predicted by neoclassical growth theory for the economy during the transition; however, its impact will not affect steady-state rate of growth (Kormendi & Meguire, 1985).

Most studies use the value of real GDP per capita of a year at the beginning of the period as initial GDP per capita (Barro, 1991; Easterly & Rebelo, 1993; Kneller et al, 1999; Levine & Renelt, 1992; Morozumi and Veiga, 2016). This variable might also appear in growth regression in the form of the log of initial GDP per capita (Bose et al, 2007) or lagged real per capita GDP (Miller and Russek, 1997). We use one-year lag of the log of GDP per capita as a proxy of initial GDP per capita.

Secondly, we look at initial school enrolment rates. Barro (1991) emphasised the important role played by human capital as a key driving force behind the research sector's generation of new products or ideas which underlie technological progress in a number of endogenous growth models. New goods are introduced to countries with greater initial stocks of human capital at a more rapid rate, ultimately

leading to faster rates of growth. Nehru et al. (1995) also focus on the significant impact of human capital formation on the long-term growth of output, especially in developing countries.

The two main proxies for human capital in Barro (1991) are the 1960 values of school enrolment at secondary and primary levels. These are similar to the measures used by Levine and Renelt (1992), and Easterly and Rebelo (1993). Landau (1983) treated these school enrolment variables as investment in education by using the measures of enrolment ratios in primary and secondary schools, the percentage of 20 to 24-year-olds within the population enrolled in higher education, and a weighted sum of these three.

Alternatively, the measures of educational attainment are based on years of schooling (Barro & Sala-i-Martin, 2004; Morozumi & Veiga, 2016). Fölster and Henrekson (2001) use growth rate of the average years of schooling as the growth of human capital

The initial school enrolment ratio in our study is a linear combination of primary, secondary and tertiary school enrolment ratios. This calculation is equivalent to Bose et al.'s (2007) methodology.

Thirdly, life expectancy represents the stock of human capital in the form of health in Barro and Sala-i-Martin (2004). The life expectancy variable in their study is the reciprocal of life expectancy at age one. These values would correspond to the mortality rate per year if mortality were independent of age.

In contrast, Barro and Lee (1994) measure life expectancy at birth by an average of values prevailing over the five years prior to the start of each decade. In our study, this variable enters the equation in the form of the log of life expectancy at birth (one-year lag).

In addition to these three state variables, we use investment, taxes and political instability as control variables in our base regression. We consider investment first. The effect of the saving rate in the neoclassical growth model is measured empirically by the ratio of real investment to real GDP (Barro & Sala-i-Martin, 2004).

The role of investment in the endogenous growth model is even more important, since an increase in capital stocks can raise the level of technology within the whole economy. This positive externality could finally enhance the steady-state rate of growth. Most literature (Barro & Lee, 1994; Fölster & Henrekson, 2001; Kneller et al., 1999; Levine & Renelt, 1992; Miller & Russek, 1997; Morozumi & Veiga, 2016) includes an investment variable as a share of GDP as a control variable in growth regression.

Secondly, we look at the role of taxes. Cashin (1995) has claimed that previous empirical studies of the influence of fiscal policies on growth have predominantly concentrated on the effects of government consumption spending and have largely ignored the effects of distortionary taxes. The importance of considering these effects too is emphasised by Kocherlakota and Yi (1997) who found that the implications for exogenous growth are usually rejected when both a tax variable and a public capital variable are included in the regression. Thus, failing to include both variables biases the results in favour of exogenous growth models.

Bose et al. (2007) claim that it is necessary to control tax revenue in order to assess fiscal-growth effects properly. The growth-enhancing effect of the provision of public goods is subjected to growth-diminishing effect of the distortionary taxes raised to fund the provision of the same public goods. Hence, tax revenue as a share of GDP is incorporated into our base regression.

Lastly, we consider political instability. Two measures of political instability have been used by Barro (1991). The first variable measures the number of revolutions and coups per year, which have also been measured by Levine and Renelt (1992). The second variable measures the number of assassinations per million population per year. These measures were interpreted as adverse influences on property rights, and thereby as negative influences on investment and growth.

The two measures can be combined as an index of political instability. Bose et al. (2007) calculate this by taking the average of revolutions and coups per year and political assassinations per million inhabitants in each decade.

Alternatively, Barro and Lee (1994) use the average number of successful and unsuccessful revolutions per year over the full sample, 1960-1985, representing the probability of revolution.

Table 4. List of control variables for base regression

Variables	**Description of the variables**
ILGDPPAX1P	Lag one year of log of GDP per capita (2005 USD)
IPST1P	Lag one year of a linear combination of school enrolment
ILLIFE1P	Lag one year of log of life expectancy
K	Gross capital formation (% of GDP)
tax_gdp	Tax revenue (% of GDP)
PINST	Average of successful coups and assassinations of executives

The calculation of our political instability index follows the definition used by Bose et al. (2007). The political instability index in our study is an average of revolutions and coups, and assassinations.

As a result, the set of control variables in base regression includes initial GDP per capita (*ILGDPPAX1P*), initial school enrolment (*IPST1P*), initial life expectancy (*ILLIFE1P*), gross capital formation as a share of GDP (*K*), tax revenue as a share of GDP (*tax_gdp*) and index of political instability (*PINST*). Table 4 shows the list of control variables.

$$GR_{it} = \beta_{0t} + \beta_1 ILGDPPAX1P_{it} + \beta_2 IPST1P_{it} + \beta_3 ILLIFE1P_{it} + \beta_4 K_{it} + \beta_5 tax\_gdp_{it} + \beta_6 PINST_{it} + \beta^M M_{it} + u_{it} \quad (9)$$

Growth regression with these six control variables including a type of public spending by function (*M*) at each point in time is exhibited in Equation (9). The effect of each type of public spending on economic growth is then analysed accordingly.

Table 5. List of variables for types of government expenditure

Variables	Description of the variables
tot_gdp	Total expenditure (% of GDP)
1. gps_gdp	Spending on general public services (% of GDP)
2. def_gdp	Spending on defence (% of GDP)
3. trc_gdp	Spending on transportation and communication (% of GDP)
4. edu_gdp	Spending on education (% of GDP)
5. hea_gdp	Spending on health (% of GDP)
6. soc_gdp	Spending on social welfare (% of GDP)

The set of variables of interest (*M*) consists of government expenditure by function according to the data from International Monetary Fund's (IMF) Government Finance Statistics (GFS), both at aggregate and disaggregated levels. They are each measured as a fraction of GDP. For the aggregate level, we use a measure of total expenditure. At the

disaggregated level, there are six variables included in our regression analysis, which are: general public services; defence; transportation and communication; education; health; and social welfare (see Table 5).

Robustness check

In addition to the set of control variables included in a base regression, we can also measure the impacts of monetary and trade policies through the ratio of broad money and trade. These are Z variables in Bose et al. (2007).

First, we consider the ratio of broad money. Some might argue that a monetary aggregate captures not only the effect of monetary policy but also the development of a financial system.

The special role played by the domestic financial development has been stressed by King and Levine (1993) and Greenwood and Jovanovic (1990). Barro and Sala-i-Martin (2004) consider two proxies for this financial development. One is the ratio of private financial system credit to GDP and the other is a measure of financial deposits (the M3 aggregate less the transactions-related M1 aggregate, as a ratio to GDP).

Similarly, Calderón and Liu (2003) employ two commonly used measures of financial development: the ratio of broad money (M2) to GDP and the ratio of credits provided by financial intermediaries to the private sector to GDP. The ratio of broad money (M2) to GDP is also used by Easterly and Rebelo (1993).

De Gregorio and Guidotti (1995) argue that credit has a clear advantage over measures of monetary aggregates in that it more accurately represents the actual volume of funds channelled into the private sector. According to De Gregorio and Guidotti's (1995) argument on sources of private funds,

it is more appropriate in our analysis to describe the ratio of M2 to GDP as a proxy of monetary policy rather than to claim it as a proxy of financial development.

Secondly, we look at the role of trade. A measure of the extent of international openness is the ratio of exports plus imports to GDP (Barro & Sala-i-Martin, 2004; Easterly & Rebelo, 1993; Miller and Russek, 1997). Some studies may include trade variables as the ratio of exports to GDP or the ratio of imports to GDP separately.

Table 6. List of variables for the robustness check

Variables	**Description of the variables**
M2	Money and quasi money comprise the sum of currency outside of banks, demand deposits other than those of the central government, and the time, savings, and foreign currency deposits of resident sectors other than the central government. (% of GDP)
TRADE	The sum of exports and imports of goods and services (% of GDP)

In our study, the other two control variables (Z), which are M2 as a fraction of GDP and trade as a fraction of GDP, are added to the set of independent variables (I) (see Equation (10)). As discussed above, these two control variables are the proxies for monetary and trade policies. The descriptions of these variables are shown in Table 6. This specification is analysed as a robustness check.

$$GR_{it} = \beta_{0t} + \beta_1 ILGDPPAX1P_{it} + \beta_2 IPST1P_{it} + \beta_3 ILLIFE1P_{it} + \beta_4 K_{it} + \beta_5 tax\_gdp_{it} + \beta_6 PINST_{it} + \beta_7 M2_{it} + \beta_8 TRADE_{it} + \beta^M M_{it} + u_{it} \quad (10)$$

Government budget constraint

Most previous studies of the association between government expenditure and growth are subject to potential biases because they omit variables that enter the government's budget constraint (Bose et al., 2007). The main elements in government budgets are revenue, expenditure, and budget balance. When incorporating government budget constraint into growth regression, however, one element of budget constraint must be omitted in order to avoid perfect multicollinearity. In other words, the regression equations need to include all but one of the possibilities for sources and uses of various revenues, various expenditures and the surplus (Miller & Russek, 1997). Hence, the coefficient on each fiscal variable is the effect of a unit change in the relevant variable offset by the effect of a unit change in the omitted fiscal variable, as explained by Kneller et al. (1999). The omitted variable should have negligible growth effects, which means that the omitted variable is supposed to have an insignificant or zero coefficient. Otherwise, the results will be biased because of the implicit partial financing by non-neutral elements of the government budget.

As in Bose et al.'s (2007) study, non-tax revenue is chosen as the implicit financing element. The coefficient of each remaining fiscal variable is the effect of a unit change in that relevant fiscal variable offset by the effect of a unit change in non-tax revenue as a share of GDP.

Budget surplus, i.e. the difference between government revenue and total public expenditure, must be added to the set of control variables in base regression. Rather than entering each type of spending into the equation separately, we must also include the other part of spending (other spending by function) in each of the equations as another control variable

$$GR_{it} = \beta_{0t} + \beta_1 ILGDPPAX1P_{it} + \beta_2 IPST1P_{it} + \beta_3 ILLIFE1P_{it} + \beta_4 K_{it} + \beta_5 tax\_gdp_{it} + \beta_6 PINST_{it} + \beta_7 SURBP_{it} + \beta_8 gps\_gdp_{it} + \beta_9 otgps\_gdp_{it} + u_{it} \quad (11)$$

Table 7. List of variables for government budget constraint

Variables	Description of the variables
SURBP	Budget surplus/deficit (% of GDP)
otgps_gdp	Public spending other than general public services spending (% of GDP)
otdef_gdp	Public spending other than defence spending (% of GDP)
ottrc_gdp	Public spending other than transportation and communication spending (% of GDP)
otedu_gdp	Public spending other than education spending (% of GDP)
othea_gdp	Public spending other than health spending (% of GDP)
otsoc_gdp	Public spending other than social welfare spending (% of GDP)

The example of growth regression shown in Equation (11) illustrates the impact of general public services spending (*gps_gdp*) on economic growth, including government budget constraint. The budget surplus is represented as a ratio of overall budget surplus/deficit as a fraction of GDP. Spending outside of the general public services category is represented as its ratio to GDP (*otgps_gdp*).

Similarly, the specification in Equation (11) is also applied to defence, transportation and communication, education, health, and social welfare spending. The details of these variables are included in Table 7.

Government budget constraint and robustness check

Finally, both the variables from government budget constraint and the robustness check are considered together with the control variables from the base regression. The example of growth regression shown in Equation (12) illustrates the impact of general public services spending (*gps_gdp*) on economic growth, including government budget constraint, monetary aggregate and trade policy. This specification is also employed with the functional spending of defence, transportation and communication, education, health, and social welfare.

$$\begin{aligned} GR_{it} = \beta_{0t} &+ \beta_1 ILGDPPAX1P_{it} + \beta_2 IPST1P_{it} \\ &+ \beta_3 ILLIFE1P_{it} + \beta_4 K_{it} + \beta_5 tax\_gdp_{it} \\ &+ \beta_6 PINST_{it} + \beta_7 M2_{it} + \beta_8 TRADE_{it} \\ &+ \beta_9 SURBP_{it} + \beta_{10} gps\_gdp_{it} \\ &+ \beta_{11} otgps\_gdp_{it} + u_{it} \end{aligned} \quad (12)$$

4.2 Endogeneity and non-linearity

In addition to four different model specifications we use for our fiscal-growth studies with classical estimates (two-way fixed effects model), the potential endogeneity of some control variables and possible non-linear relationship between growth and public spending are also investigated. This verification involves some misspecification tests (the Durbin-Wu-Hausman test and the RESET test).

Endogeneity

Linking public spending with growth requires the use of control variables, and therefore an underlying endogeneity

issue may arise from the problems of simultaneity and reverse causality.

In our set of aforementioned control variables, tax revenue and investment are susceptible to this endogeneity problem. With such a problem, ordinary least squares method will not yield consistent estimates.

Using the Durbin-Wu-Hausman test, we can confirm that our two-way fixed effects model for four different specifications is subject to an endogeneity problem. We then use instrumental estimates - namely two-stage least squares (2SLS) - to take the endogeneity problem into account. One-year lag variables are instruments for both tax revenue and investment.

Non-linearity

A potential non-linear relationship between growth and public spending has been shown by Barro (1990): growth rate increases with public spending when a government is small, but declines if a government becomes large.

Since Ramsey's RESET test has detected the non-linearity for the relationship between public spending and economic growth, we include the quadratic term of public spending to capture this non-linear impact, both at aggregated and disaggregated level.

4.3 Regression results

We are interested in investigating the different permanent growth impacts of various types of public spending between developing and high-income countries, using cross-section and time series data. By separately analysing the set of results for developing and high-income countries, heterogeneity bias in the panel data is partially controlled. Since the estimation of the two-way fixed effects

model contains an endogeneity problem, we mainly report the results with instrumental estimates using two-stage least squares (2SLS). In addition, the potential non-linear relationship between public spending and growth is examined by using the square term of public spending.

In each of the following tables (Table 8 to 11), we report the results of a particular type of public spending with six different model specifications. The first specification is the two-way fixed effects model of base regression. The second to the fifth specifications are instrumental estimates with year and country fixed effects of base regression, regression for the robustness check, regression with government budget constraint, and regression with government budget constraint and a robustness check. In the sixth specification, the square term of public spending as a share of GDP is added to the equation of the fifth specification in order to identify any non-linear relationship between public spending and economic growth.

Particular attention should be paid to the fifth and the sixth specifications, since the biases of the estimates and the endogeneity problem have been dealt with.

Based on the fact that transportation and communication is the only type of functional spending that has a statistically significant positive relationship with growth, our discussion then focusses only on the role of total spending and transportation and communication spending in determining economic growth for developing and high-income countries in our sample.

Developing countries

We firstly discuss the effects of total spending on economic growth in developing countries. As can be seen from Table 8, the impact of an increase in total spending on

economic growth is sensitive to the set of control variables. Nonetheless, the positive growth effect of additional spending exists once government budget constraint has been taken into account. The instrumental estimate in Column (5) of Table 8 shows that a one percentage to GDP increase in public spending raises per capita GDP growth by 0.14%. However, the net growth effects of an increase in public spending would become negative from the adverse impact of raising tax revenue as a source of funds for additional spending.

In Column (6) of Table 8, the non-linear specification suggests that the net negative effects of public spending on growth presented in Column (5) can be reversed by the positive coefficient of the square term of total spending when the size of total spending is large enough. This can be referred to in cases where developing countries might underspend government expenditure. Therefore, the positive effect of fiscal policy has not yet been achieved at high level of public spending.

In terms of the effects of state variables, a developing country with a high initial GDP per capita will experience low per capita growth. A one percentage increase in initial GDP per capita implies a 0.06% to 0.07% decrease in per capita GDP growth. This evidence supports the conditional convergence hypothesis.

For initial human capital, initial school enrolment rate has insignificant relationship with growth while higher initial life expectancy has a favourable impact on economic development. Per capita GDP growth of developing Sample 1 countries could increase by as much as 0.13% as a result of a 1% rise in life expectancy.

Table 8. Growth regressions with total public spending of developing countries in our sample (1972-2012)

Estimation method	OLS	2SLS	2SLS	2SLS	2SLS	2SLS
Dependent variable	GR	GR	GR	GR	GR	GR
Endogenous variable		tax gdp K	tax gdp K	tax gdp K	tax gdp K	tax gdp K
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Regressor	**b/se**	**b/se**	**b/se**	**b/se**	**b/se**	**b/se**
Initial GDP per capita	-6.9673***	-6.2327***	-6.2231***	-7.1247***	-6.9561***	-6.7273***
	(1.06)	*(1.11)*	*(1.22)*	*(1.14)*	*(1.25)*	*(1.25)*
Initial school enrolment	-0.0100	-0.0215	-0.0228	-0.0407	-0.0365	-0.0270
	(0.05)	*(0.05)*	*(0.05)*	*(0.05)*	*(0.05)*	*(0.05)*
Initial life expectancy	-0.6912	6.2828	10.9079**	10.2104**	13.4883***	13.1456***
	(4.44)	*(4.87)*	*(4.96)*	*(4.83)*	*(4.88)*	*(4.88)*
Gross capital formation (% of GDP)	0.2261***	0.0876**	0.0699*	0.0471	0.0406	0.0373
	(0.03)	*(0.04)*	*(0.04)*	*(0.04)*	*(0.04)*	*(0.04)*
Taxes (% of GDP)	-0.0588	-0.0757	-0.0566	-0.2126***	-0.3021***	-0.2794***
	(0.05)	*(0.07)*	*(0.08)*	*(0.08)*	*(0.10)*	*(0.10)*
Political instability	-3.3267*	-3.4360*	-3.5224*	-3.5453*	-3.6392*	-3.6926**
	(1.92)	*(1.91)*	*(1.89)*	*(1.89)*	*(1.87)*	*(1.87)*
M2 (% of GDP)			-0.0467***		-0.0325**	-0.0363**
			(0.02)		*(0.02)*	*(0.02)*
Trade (% of GDP)			0.0476***		0.0431***	0.0396***
			(0.01)		*(0.01)*	*(0.01)*
Budget surplus (% of GDP)				0.3349***	0.3965***	0.4207***
				(0.06)	*(0.07)*	*(0.07)*
Total spending (% of GDP)	-0.0990***	-0.0851***	-0.0866**	0.0895*	0.1386**	-0.0140
	(0.03)	*(0.03)*	*(0.03)*	*(0.05)*	*(0.06)*	*(0.09)*
Square term of total spending (% of GDP)						0.0022**
						(0.00)
Number of observations	910	879	870	872	863	863

Notes: Standard errors in parentheses below parameters
***, **, * Statistical significance at 1%, 5% and 10% respectively

The OLS estimates in Column (1) of Table 8 suggest that a 1% of GDP increase in investment can be converted to the increment of 0.23% per capita growth. Instrumental estimates have shown that this positive outcome is overstated. In fact, the increase might be less than 0.10%.

As expected, an increase in tax revenue deteriorates growth, since it distorts investment decisions and can also be a disincentive to labour. The negative growth effect of additional taxes is large when taking government budget constraint into account. This can be interpreted as showing that the detrimental effect is exacerbated when a government's resources are relatively limited.

Political instability is conceivably a factor that undermines economic growth, particularly in developing countries through coups or political assassinations. The coefficients for political instability are negatively significant.

An increase in the ratio of monetary aggregates to GDP has an adverse impact on growth. In this case, it can be argued that M2 as a percentage of GDP might not be a legitimate proxy for financial sophistication in developing countries. In fact, national government uses money creation as a way to monetise its debt in order to pay for budget deficits. In this process, debt issued by the government is purchased by created money from the central bank. This can lead to hyperinflation, particularly when such transactions are carried out unaccountably and excessively. As a result of this hidden tax, consumers then lose purchasing power. Therefore, debt monetisation could have a growth-deterring impact.

As one might expect, the growth effect of trade openness is favourable. However, the impact might be less than we would have expected. An increase of one percent of GDP in trade ratio can boost per capita GDP growth of developing Sample 1 countries by 0.04% to 0.05%.

Table 9. Growth regressions with transportation and communication spending of developing countries in our sample (1972-2012)

Estimation method	OLS	2SLS	2SLS	2SLS	2SLS	2SLS
Dependent variable	GR	GR	GR	GR	GR	GR
Endogenous variable		tax_gdp K	tax_gdp K	tax_gdp K	tax_gdp K	tax_gdp K
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Regressor	**b/se**	**b/se**	**b/se**	**b/se**	**b/se**	**b/se**
Initial GDP per capita	-7.9854***	-7.3516***	-6.8430***	-8.1701***	-7.5718***	-7.8365***
	(1.11)	*(1.16)*	*(1.29)*	*(1.19)*	*(1.31)*	*(1.34)*
Initial school enrolment	-0.0225	-0.0183	-0.0150	-0.0200	-0.0125	-0.0001
	(0.05)	*(0.05)*	*(0.05)*	*(0.05)*	*(0.05)*	*(0.05)*
Initial life expectancy	-6.9163	0.2193	4.2903	4.6440	8.1199	10.0176*
	(4.70)	*(5.12)*	*(5.17)*	*(5.09)*	*(5.16)*	*(5.27)*
Gross capital formation (% of GDP)	0.2249***	0.0910**	0.0760**	0.0467	0.0408	0.0226
	(0.03)	*(0.04)*	*(0.04)*	*(0.04)*	*(0.04)*	*(0.04)*
Taxes (% of GDP)	-0.1599***	-0.1689***	-0.1436**	-0.2189***	-0.2895***	-0.3044***
	(0.05)	*(0.06)*	*(0.07)*	*(0.08)*	*(0.10)*	*(0.10)*
Political instability	-2.5557	-2.7249	-2.9376	-2.8973	-3.1152	-3.0671
	(2.09)	*(2.08)*	*(2.06)*	*(2.04)*	*(2.02)*	*(2.03)*
M2 (% of GDP)			-0.0533***		-0.0388**	-0.0394**
			(0.02)		*(0.02)*	*(0.02)*
Trade (% of GDP)			0.0395***		0.0380***	0.0368***
			(0.01)		*(0.01)*	*(0.01)*
Budget surplus (% of GDP)				0.3682***	0.4199***	0.4216***
				(0.06)	*(0.07)*	*(0.07)*
Transportation and communication spending (% of GDP)	0.1246	0.0453	0.1139	0.6169***	0.6669***	1.1504***
	(0.17)	*(0.17)*	*(0.17)*	*(0.19)*	*(0.19)*	*(0.40)*
Other spending (% of GDP)				0.0751	0.1171**	-0.1406
				(0.05)	*(0.06)*	*(0.06)*
Square term of transportation and communication spending (% of GDP)						-0.0688
						(0.04)
Square term of other spending (% of GDP)						0.0042**
						(0.00)
Number of observations	850	823	814	816	807	807

Notes: Standard errors in parentheses below parameters
***, **, * Statistical significance at 1%, 5% and 10% respectively

The improvement of budget balance has a positive effect on economic growth. This reflects the importance of fiscal health and the fiscal responsibility of a government in determining economic development in developing countries.

The impact of an increase in transportation and communication spending on economic growth for developing countries is presented in Table 9. As with total spending, an increase in transportation and communication spending is positively and significantly related to economic growth, especially when government budget constraint is inclusively considered. The instrumental estimate in Column (5) of Table 9 shows that a 1% of GDP increase in transportation and communication spending can raise per capita growth rate by 0.67%.

Subsidising the increase of the spending by reducing other types of spending, the net positive effect of transportation and communication on economic growth is partially reduced. The non-linear estimation in Column (6) of Table 9 has shown that the partial relationship between transportation and communication spending and per capita GDP growth is concave.

The concavity suggests that the positive impact of transportation and communication spending on economic growth is somewhat restrained. Our results have shown that any increment increase of transportation and communication spending while its level is above 8% of GDP will have opposing effect on growth in developing countries.

The effects of control variables on growth in the regressions with transportation and communication spending of developing countries are relatively similar to growth regressions with total spending. The only difference is that the coefficients of initial life expectancy and political instability have become insignificant, although they are still positive and negative respectively.

The results for growth regression with other types of functional spending are not shown. However, the increases in these spending types have either insignificant or negative significant relationships with growth. With linear specifications, the increases in general public services, defence and health spending have insignificant effects on per capita GDP growth, whereas rises in education and social welfare spending have growth-diminishing effects.

High-income countries

The estimates in Table 10 illustrate the effects of increases in total spending on per capita GDP growth of high-income countries.

An increase in total public spending in high-income countries has a negative impact on per capita GDP growth, except in the growth regression which includes both government budget constraint and the robustness check in Column (5), where its coefficient is insignificant. The coefficient of the square term of total spending in the non-linear specification is positive and significant, suggesting that an increase in total spending when its level has already been exceptionally high could promote growth. In order to raise total spending, the main source of funds will be tax collection, which has a growth-deteriorating effect, although the coefficient of taxes is insignificant.

As a result, the level of total spending in the range that needs to be matched seems to be unattainable.

Table 10. Growth regressions with total public spending of high-income countries in our sample (1972-2012)

Estimation method	OLS	2SLS	2SLS	2SLS	2SLS	2SLS
Dependent variable	GR	GR	GR	GR	GR	GR
Endogenous variable		tax gdp K	tax gdp K	tax gdp K	tax gdp K	tax gdp K
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Regressor	**b/se**	**b/se**	**b/se**	**b/se**	**b/se**	**b/se**
Initial GDP per capita	-7.1485***	-5.2028***	-4.9127***	-5.2676***	-5.2940***	-5.0356***
	(0.77)	*(0.87)*	*(0.96)*	*(0.90)*	*(0.99)*	*(1.00)*
Initial school enrolment	0.0488***	0.0262	0.0220	0.0251	0.0153	0.0191
	(0.02)	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*
Initial life expectancy	6.8907	21.3283**	21.0727**	21.6753***	23.2569***	21.7850**
	(7.36)	*(8.30)*	*(8.76)*	*(8.35)*	*(8.82)*	*(8.87)*
Gross capital formation (% of GDP)	0.3699***	0.0289	0.0377	0.0301	0.0458	0.0308
	(0.03)	*(0.04)*	*(0.05)*	*(0.04)*	*(0.05)*	*(0.05)*
Taxes (% of GDP)	-0.0231	0.0460	0.0104	0.0304	-0.0821	-0.1281
	(0.04)	*(0.06)*	*(0.07)*	*(0.09)*	*(0.10)*	*(0.11)*
Political instability	1.8894	1.9113	2.4215	1.9764	2.8326	3.2460
	(2.33)	*(2.47)*	*(2.50)*	*(2.48)*	*(2.50)*	*(2.52)*
M2 (% of GDP)			-0.0124***		-0.0135***	-0.0150***
			(0.00)		*(0.00)*	*(0.00)*
Trade (% of GDP)			0.0271***		0.0281***	0.0234***
			(0.01)		*(0.01)*	*(0.01)*
Budget surplus (% of GDP)				0.0190	0.1085*	0.1213*
				(0.06)	*(0.07)*	*(0.07)*
Total spending (% of GDP)	-0.0845***	-0.1487***	-0.1275***	-0.1373***	-0.0614	-0.2043**
	(0.02)	*(0.03)*	*(0.03)*	*(0.05)*	*(0.06)*	*(0.08)*
Square term of total spending (% of GDP)						0.0017**
						(0.00)
Number of observations	1115	1097	920	1097	920	920

Notes: Standard errors in parentheses below parameters
***, **, * Statistical significance at 1%, 5% and 10% respectively

The effects of state variables on per capita GDP growth of high-income countries are similar to that of developing countries. A 1% increase of initial GDP per capita leads to a decline of per capita growth by 0.05% to 0.07%. Initial school enrolment rate is not significantly linked with per capita GDP growth, whereas an increase in initial life expectancy is growth-promoting. A 1% rise in life expectancy may increase per capita GDP growth by up to 0.23%.

The coefficients of gross capital formation are positive but insignificant. Neither taxes nor political instability are significantly related to per capita GDP growth.

The robustness check confirms a growth-enhancing effect of trade openness which is lower than that of developing countries. However, an increase in M2 as a percentage of GDP has a detrimental effect on growth. High M2 as a percentage of GDP reflects a tendency for the government to engage in inflation financing. This is a relatively inefficient form of taxation.

Budget surplus may also have a positive relationship with economic growth, even though the effects might not be as trivial as they are in developing countries.

The effects of an increase in transportation and communication spending on growth in high-income countries are considered by using the estimates from Table 11. A 1% of GDP increase in transportation and communication spending raises per capita growth rate by 1.2%, as can be seen from the specification in Column (5).

Table 11. Growth regressions with transportation and communication spending of high-income countries in our sample (1972-2012)

Estimation method	OLS	2SLS	2SLS	2SLS	2SLS	2SLS
Dependent variable	GR	GR	GR	GR	GR	GR
Endogenous variable		tax gdp K	tax gdp K	tax gdp K	tax gdp K	tax gdp K
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Regressor	**b/se**	**b/se**	**b/se**	**b/se**	**b/se**	**b/se**
Initial GDP per capita	-7.2272***	-5.3636***	-6.4640***	-5.0866***	-6.5818***	-6.5007***
	(0.81)	*(0.90)*	*(1.04)*	*(0.91)*	*(1.07)*	*(1.08)*
Initial school enrolment	0.0317*	-0.0007	0.0093	0.0193	0.0315	0.0331
	(0.02)	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*	*(0.02)*
Initial life expectancy	12.9068*	28.0563***	31.0129***	25.0199***	27.7952***	25.9299***
	(7.76)	*(8.48)*	*(9.16)*	*(8.30)*	*(9.00)*	*(8.99)*
Gross capital formation (% of GDP)	0.3866***	0.0471	0.0442	0.0061	-0.0029	-0.0030
	(0.03)	*(0.04)*	*(0.05)*	*(0.05)*	*(0.05)*	*(0.05)*
Taxes (% of GDP)	-0.0726**	-0.1146**	-0.1437***	0.0103	-0.1253	-0.1516
	(0.04)	*(0.05)*	*(0.06)*	*(0.09)*	*(0.11)*	*(0.11)*
Political instability	1.9546	2.2064	2.7876	2.6683	3.4355	3.8010
	(2.33)	*(2.47)*	*(2.58)*	*(2.42)*	*(2.52)*	*(2.52)*
M2 (% of GDP)			-0.0151***		-0.0099**	-0.0109**
			(0.00)		*(0.00)*	*(0.00)*
Trade (% of GDP)			0.0291***		0.0238***	0.0217**
			(0.01)		*(0.01)*	*(0.01)*
Budget surplus (% of GDP)				0.0630	0.1589**	0.1660**
				(0.06)	*(0.07)*	*(0.07)*
Transportation and communication spending (% of GDP)	0.0480	0.0819	0.8324***	0.1222	1.2017***	2.2411***
	(0.11)	*(0.12)*	*(0.23)*	*(0.13)*	*(0.26)*	*(0.65)*
Other spending (% of GDP)				-0.1227**	-0.0640	-0.2003**
				(0.05)	*(0.06)*	*(0.06)*
Square term of transportation and communication spending (% of GDP)						-0.3210*
						(0.17)
Square term of other spending (% of GDP)						0.0017**
						(0.00)
Number of observations	1073	1057	893	1048	884	884

Notes: Standard errors in parentheses below parameters
***, **, * Statistical significance at 1%, 5% and 10% respectively

The non-linear specification has demonstrated that the partial relationship between transportation and communication spending and growth in high-income countries is also concave. The positive growth impact of additional transportation and communication spending within high-income countries might only be attained when the level of spending is below 4% of GDP.

The impacts of other control variables on growth are congruent with those of estimates with total public spending. Therefore, these variables in Table 11 are not discussed.

In contrast to transportation and communication spending, increases in spending on general public services, education and social welfare have a deteriorating impact on growth with linear specifications. Spending on defence and health is not significantly related to per capita GDP growth.

4.4 Comparison of our study with previous results

Our fiscal-growth studies estimates can be compared to those in earlier literature. The results for developing countries will be primarily compared with those obtained by Bose et al. (2007). We should note that the two studies draw data from different time periods. While Bose et al. (2007) use decade averages over the 1970s and 1980s, our study uses annual data from 1972 to 2012. Where possible, the estimates for high-income countries are also discussed. The effects of both public spending variables and control variables on economic growth are evaluated respectively.

Public spending

The effects of an increase in total public spending on economic growth are mostly found to be growth-diminishing in cross-country studies. The studies of Lin (1994), and

Jiranyakul and Brahmasrene (2007) are some of the exceptions in which a growth-enhancing effect from additional government expenditure was found. Most studies using samples of high-income countries find negative impacts of increased total spending on growth (Bergh & Karlsson, 2010; Fölster & Henrekson, 2001; Romero-Avila & Strauch, 2008), whereas the growth impacts from increased spending of developing countries are not unanimous.

Our results for high-income countries with adverse effects on growth from an increase in total public spending are comparable to those in the majority of previous studies. The analysis of developing countries confirms the sensitivity of the results.

Unlike Bayraktar and Moreno-Dodson (2015), and Christie (2014), who found that the non-linear term of public spending is insignificantly related to growth, we found the coefficients of the square term of total spending to be positive and significant for both developing and high-income countries.

In Bose et al. (2007), in terms of public spending by function, education, transportation and communication, and defence spending have positive significant relationships with economic growth in base regression and regression for the robustness check. Interestingly, the results change dramatically when the government budget constraint is taken into account, with education being the only spending type positively related to growth. In our study, only transportation and communication spending promotes growth, as can be seen in Table 12.

Table 12. Comparison between the results of Bose et al.'s (2007) study and our study (expenditure variables)

Expenditure/ studies	**Bose et al. (2007)**	**Our study**
Base regression		
Education	Positively significant	Negatively significant
Transportation and communication	Positively significant	Insignificant
Defence	Positively significant	Insignificant
Robustness check		
Education	Positively significant	Negatively significant
Transportation and communication	Positively significant	Insignificant
Defence	Positively significant	Insignificant
Government budget constraint		
Education	Positively significant	Negatively significant
Transportation and communication	Insignificant	Positively significant
Defence	Insignificant	Insignificant

This significant change of the estimates has underlined the bias of estimates where the role of government budget constraint is neglected. We can further compare the effects of each spending type by function in our study to those in other literature. The growth-enhancing effect of transportation and

communication spending found in our study is consistent with that found in pre-existing studies (Aschauer, 1989; Easterly & Rebelo, 1993; Nurudeen & Usman, 2010). Our results earn further merits in detecting the concave relationship between transportation and communication spending and per capita GDP growth of the countries in our sample. Specifically, developing countries may use transportation and communication spending to promote growth to a greater extent than high-income countries did. This highlights the role played by government spending in providing public infrastructure, especially for a country at the initial stages of development.

Education spending is mostly found to be insignificantly or positively related to economic growth in preceding research. Although the positive growth impact of education spending in our study is not found in linear regression, non-linear specification for developing countries has shown education spending to have a favourable growth effect at the level of spending below 4% of GDP. A few studies (Kelly, 1997; Nurudeen & Usman, 2010) show contradicting results with regard to adverse growth impacts of increased education spending. Interestingly, the partial non-linear relationship between education spending and growth in high-income countries in our sample is convex. This might not provide the counter-argument towards the growth-promoting effect of education spending in high-income countries. It does, perhaps, suggest that these high-income countries spend on education efficiently, by mainly using either private funds or public spending. This could also be related to economies of scale in spending on education.

While most studies argue that increased defence spending has a negative effect on economic growth (Abdullah et al, 2009; Deger & Smith, 1983; Knight et al., 1996), some literature has found a positive (Benoit, 1978) or

neutral growth impact (Barro & Sala-i-Martin, 2004; Biswas & Ram, 1986). Frederiksen and Looney (1983) illustrated that the growth impact of additional spending on defence depends on resource constraint. Countries which are relatively resource-constrained experience a growth-diminishing impact of an increase in defence spending, whereas a positive growth effect is otherwise found. Hence, the insignificant growth effect of increased defence spending in our developing and high-income countries can be appropriately explained by Frederiksen and Looney's argument. Since each group of countries in our study may include both countries with and without resource constraint in relative terms, growth impact from increased spending in defence is not detected.

Health spending is generally expected to have a positive relationship with economic growth (Abdullah et al, 2009; Nketiah-Amponsah, 2009; Nurudeen & Usman, 2010). However, Kelly (1997) found a negative growth effect of increased health spending. Our estimates exhibit an insignificant relationship between health expenditure and the economic growth of developing and high-income countries.

Although Kelly (1997) has found that an increase in social welfare spending is growth-conducive, our analysis reveals opposite results. In recent decades, social welfare spending has increased dramatically due to population ageing. Recent data should be able to detect a negative growth effect of increased social welfare spending rather than a positive one.

The effects of general public services spending on growth are hardly mentioned in fiscal-growth studies. In our study, the growth impact of additional general public services spending is negative for high-income countries. This relationship is insignificant for developing countries in our sample.

Control variables

The effects of control variables in our fiscal-growth studies can also be compared to those reported in earlier studies, including Bose et al. (2007). This comparison is illustrated in Table 13.

The state variables in our model specification include initial GDP per capita, initial school enrolment rate and initial life expectancy. Most studies confirm the conditional convergence hypothesis with negative coefficient for initial GDP per capita (Barro, 1991; Barro & Lee, 1994; Fölster & Henrekson, 2001; Kneller et al., 1999; Miller & Russek, 1997; Morozumi & Veiga, 2016). Our estimates for both developing and high-income countries also provide consistent evidence in comparison with previous studies.

The relationship between initial school enrolment ratio and growth is predominantly found to be insignificant (Barro & Lee, 1994; Gemmell, 1996; Morozumi & Veiga, 2016; Pritchett, 2001) apart from in Barro (1991) and Benhabib and Spiegel (1994) where positive relationships were found. Our results conform to those in the majority of studies.

While Bose et al. (2007) failed to detect a growth-enhancing effect of an increase in initial life expectancy in their sample of developing countries, our study has found a positive relationship between initial life expectancy and per capita growth which is similar to that found in Barro and Lee (1994), and Barro and Sala-i-Martin (2004).

Hence, the growth-promoting effect of initial human capital in the endogenous growth model is exhibited in our study only through initial life expectancy.

The other control variables in our base regression are investment, taxes and political instability. Vast amount of studies, including Bose et al. (2007), have found a positive

relationship between investment and growth. When controlling for endogeneity, the positive effect of investment on growth in developing countries in our study is significantly reduced. For this reason, some preceding studies might have overstated the favourable growth effect of investment. The relationship between investment and growth in high-income countries is insignificant, as in the findings of Kneller et al. (1999).

Increased tax revenue mostly has a detrimental effect on growth. Distortionary taxation (Abdullah et al, 2009; Cashin, 1995; Kneller et al., 1999) and direct taxation (Romero-Avila & Strauch, 2008) are usually presented as proxies for government revenue. We find a negative growth impact for additional taxes, especially in developing countries within our sample.

The results of Barro (1991) and Barro and Lee (1994) show the growth-retarding effect of an increase in political instability. The estimates for developing countries are consistent with previous studies, whereas the coefficients of political instability are insignificant for high-income countries.

The effects of monetary policy and trade are also examined in the regression for the robustness check.

Barro and Sala-i-Martin (2004) found that an increase in monetary aggregates has an insignificant relationship with economic growth. This finding is in agreement with that of Bose et al (2007). However, Calderón and Liu (2003) use both the ratios of monetary aggregates and credits to GDP to represent financial development. They find that financial development has a favourable growth impact. The results from our study have demonstrated detrimental growth effects from increased M2 as a percentage of GDP. We argue that the ratio of monetary aggregates to GDP in developing countries may instead reveal the growth impact from

monetisation of government debt. The adverse effect in high-income countries might be influenced by the fact that countries with high levels of M2 as percentages of GDP are the ones with low per capita GDP growth.

Table 13. Comparison between the results of Bose et al.'s (2007) study and our study (control variables)

Control variables/ studies	**Bose et al. (2007)**	**Our study**
State variables		
Initial GDP per capita	Insignificant	Negatively significant
Initial school enrolment	Negative (some significance)	Insignificant
Initial life expectancy	Insignificant	Positive (some significance)
Other control variables		
Investment	Positively significant	Positive (some significance)
Taxes	Insignificant	Negatively significant
Political instability	Insignificant	Negative (some significance)
Robustness check		
M2	Insignificant	Negatively significant
TRADE	Insignificant	Positively significant
Government budget constraint		
Budget surplus	Positively significant	Positively significant

An increase in trade openness could be growth-promoting. It increases opportunities for countries to better

utilise their comparative advantages. Our results are in agreement with Barro and Sala-i-Martin's (2004). In contrast, the coefficients of trade ratio in Miller and Russek (1997) and Romero-Avila and Strauch (2008) are found to be insignificant.

Budget surplus has been shown to have a favourable growth effect (Easterly & Rebelo, 1993; Kneller et al., 1999; Miller & Russek, 1997). This positive effect can also be established for both developing and high-income countries in our study. This confirms the important role played by fiscal responsibility in determining economic growth.

5. Concluding remarks

When comparing public expenditure as a ratio of GDP between 1972 and 2012 within our sample, the figures have shown that, on average, the size of government in high-income countries (34.82%) is greater than in developing countries (26.63%). This is mainly driven by the high levels of social welfare and healthcare spending in high-income countries. From the composition of public spending in the past four decades, it has been shown that social welfare spending as a share of total spending has increased significantly in developing countries while remaining high in high-income countries. In contrast, defence spending, and transportation and communication spending are decreasing over time, both as percentage of GDP and as a ratio of total spending. The proportion of education spending as share of total expenditure in developing countries (12.96%) is higher than in high-income countries (9.07%). Population aging is a global trend which will continue to be an important factor determining the level and allocation of government spending, especially with regard to potentially high levels of social welfare and health spending, for the next decade. This

problem could become another obstacle for any developing country which tries to escape from the middle-income trap, since it becomes more challenging to channel sufficient public spending for productive use.

Under the framework used by Bose et al. (2007), our disaggregated analysis of the relationship between public expenditure and economic growth for groups of countries with different income levels also takes into account the problem of endogeneity from taxes and investment, and the potential non-linear relationship between public spending and economic growth. As with previous studies, the estimates confirm the growth-diminishing effect of an increase in public spending in high-income countries. The non-linear specification has shown that some developing countries' governments may be underspending on public expenditure provided that the square term of their country's total spending has a positive significant coefficient.

Transportation and communication is the only type of spending for which an increase has a favourable growth impact in both developing and high-income countries using linear regression. With non-linear specification, the partial relationship between this type of spending and economic growth is concave. This suggests that the growth-promoting impact of transport and communication spending can be attained up to certain level of spending as a share of GDP. Developing countries may have more room to manoeuvre than high-income countries. Our results have shown that an increase in transportation and communication can be growth-enhancing up to the level of spending of 8% of GDP in developing countries and 4% of GDP in high-income countries. In our study, other types of spending have either insignificant or negative relationships with economic growth.

The relationship between control variables and economic growth in our study is principally consistent with previous

studies. In terms of state variables, the evidence of conditional convergence hypothesis is prevalent. Although the school enrolment ratios are not significantly related to per capita GDP growth, initial life expectancy has a positive significant coefficient, especially for the estimates of high-income countries.

Without controlling for endogeneity, the positive growth impact of increased investment shown in prior studies might have been overestimated. An increase in tax revenue produces a growth-declining impact, especially for developing countries. Political instability can have a negative impact on growth in developing countries. While an increase in the trade ratio is growth-promoting, additional monetary aggregates can be harmful to growth. The underlying reason can be that a significant proportion of government debt is monetised. The positive association between budget surplus and growth reveals the externalities from government's financial responsibility.

To conclude, governments must take into account the increasing importance of social welfare and healthcare spending over time, especially in developing countries. They need to find the appropriate way in which to finance welfare spending; either by decreasing other types of expenditure or by raising additional revenue. Moreover, a disaggregated analysis of public expenditure and growth suggests the importance of the role played by increased transportation and communication spending in enhancing economic growth. This emphasises the significance of additional public infrastructure investment - something that governments need to be responsible for. It should also be noted that the relationship between public spending and growth might be non-linear. As a result, the dynamism of fiscal policies is also required. Lastly, budget balance is the factor that not only represents a national government's fiscal position but also

indicates better potential for growth in implementing fiscal policy.

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