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Economic growth and government size in developed European countries: A panel threshold approach

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ABSTRACT

Based on the literature on economic growth, there is a non-linear relationship between government size and economic growth, which is usually similar to an inverted U-shaped curve and is used to determine the optimum share of government expenditure. The present study aims to investigate the non-linear relationship among 14 developed European countries during 1995–2014. Final consumption expenditure to gross domestic product (FCE), current expenditure other than final consumption to gross domestic product (OCE), and government gross fixed capital formation to gross domestic product (GFCF) were considered for measuring government size. The results indicate an asymmetric effect of FCE and GFCF on economic growth when they are above and below the optimal level. The optimum values of FEC and GFCF were estimated to be 16.63 and 2.31%, respectively. However, it is noted that OCE always has a negative effect on economic growth. In terms of policy prescriptions, governments of developed countries should be aware that misallocation of public expenditure can occur given it may likely become unproductive after passing an optimal size.

1. Introduction

Sustainable economic growth is regarded as a discovery process which is generally guaranteed by the market mechanism. However, the effect of government size on economic growth is a controversial issue. Obviously, government should play a role in different areas such as the security of property rights and providing the proper environment for private activities. Accordingly, a decrease in transaction costs leads to an increase in investment and production. Government can also provide infrastructure, public health, and education since the private sector cannot implement them sufficiently for the whole community. Hence, government efforts lead to higher economic growth through entering those sectors in which the market mechanism fails or are more efficient, compared to the private sector. In this regard, some empirical studies have indicated a positive effect of government size on economic growth (Ram, 1986; Bose et al., 2007; Romero-Ávila and Strauch, 2008; Ghose and Das, 2013).

Government, on the other hand, cannot allocate very large sums to expenditure given its corresponding need to finance expenditure by borrowing and taxes. However, borrowing may increase the financial costs of investment, displace private investment and increase taxes in the future. Taxes may distort resource allocation which results in discouraging economic agents. In addition, centralization and bureaucracy decrease creativity in both public and private sectors. Thus, the trend

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of growth is disturbed or lowed due to government interferences leading to a decrease in creativity and an increase in inefficiency simultaneously (Guseh, 1997; Gwartney et al., 1998; Fölster and Henrekson, 2001; Dar and Amir Khalkhali, 2002; Romero-Ávila and Strauch, 2008; Afonso and Furceri, 2010).

Therefore, government activities can play both a positive and negative role in economic growth. The final effect of government expenditure on economic growth depends on a number of factors such as the amount and types of expenditure. In fact, large increases in government expenditure typically lead to an increase in the negative effects which may create a non-linear relationship between government size and economic growth. In such cases, the positive effect of government expenditure may be ultimately reversed (Barro, 1990; Mourmouras and Lee, 1999; Kosempel, 2004; Agénor, 2010). This non-linear relationship is an inverted U-shaped curve known as the "Barro curve" in the growth literature, and is used to determine the optimum share for government expenditure.

The present study, considering the above literature, aims to investigate whether different types of government expenditure play a non-linear role on economic growth among 14 European Union countries. Therefore, the study differs from previous studies for the following reasons. First, we re-examines the relationship between government expenditure and economic growth using a more appropriate econometric approach. This includes a robustness check with different control variables and a methodology used for instrument variable. The previous empirical studies often estimated a linear effect among a large number of the developed countries. A few have applied various non-linear methods such as quadratic form, threshold autoregressive, and data envelopment analysis for calculating the optimum size of government (Ram, 1986; Barro, 1991; Vedder and Gallaway, 1998; Chiou-Wei et al., 2010; Christie, 2014; Asimakopoulos and Karavias, 2016). However, the data envelopment analysis is a mathematical programming method which may produce biased results due to the non-stochastic nature and its estimates cannot be easily validated using usual diagnostic tools. The quadratic form model cannot estimate the optimal size directly.

Second, a review of the previous studies indicates that the samples include a mixture of heterogeneous countries. In the present study, 14 more homogeneous developed countries in the European Union were selected in order to create a roughly equal optimum size. In addition, the above-mentioned methods failed to consider the heterogeneity of regional and time differences. This study seeks to evaluate these differences using the panel threshold model based on a two-way error component.

Finally, the previous studies applied a number of measures such as final consumption expenditure, investment expenditure, and taxation without examining the effect of current expenditure except that of final consumption. Hence, the present study uses government expenditure including final consumption expenditure, current expenditure rather than final consumption, and fixed investment expenditure in order to improve the budgetary policies in the European Union.

In sum, although the effect of final government expenditure on economic growth has been reported in a large number of studies, this study re-examines the relationship in more detail for different types of government expenditure among the countries included in the European Union. In this way, the present paper aims to provide empirical evidence for the non-linear effects of different types of government expenditure on economic growth.

Sections 2 and 3 give a brief overview of other theoretical and empirical studies. Section 4 describes the data and base model. Section 5 describes the panel threshold model. Section 6 reports the empirical results including robustness tests. Section 7 presents the conclusions.

2. Theoretical review of the literature

Barro (1990) first considered the public sector in an endogenous growth model. Based on this framework, Barro (1990, 1991) assumes that governments spend tax income on providing public services so that all producers have the same share without any congest effect. Hence, the following AK form represents a sample of firm production:

$$Y(t) = AK(t)^{\alpha} G(t)^{1-\alpha}, \qquad 0 < \alpha < 1. \tag{1}$$

The utility function takes the constant intertemporal elasticity of substitution (CIES) form:

$$u[c(t)] = \begin{cases} \dfrac{c(t)^{1-\sigma}}{1-\sigma}, & \sigma \geq 0, \sigma \neq 1, \\ Ln\, c(t), & \sigma = 1. \end{cases} \tag{2}$$

The equilibrium condition is $Y(t) \equiv C(t) + I(t) + G(t)$. Based on the infinite horizon Ramsey model, the steady state growth rate is determined by:

$$\frac{\dot{Y}(t)}{Y(t)} = \sigma^{-1} \left[\alpha (1 - \tau_G) A^{1/\alpha} \tau_G^{(1-\alpha)/\alpha} - \delta - \rho \right]. \tag{3}$$

Therefore, government size (τ_G) has both positive and negative effects on the growth rate. Since the capital share parameter (α) ranges between zero and one, a reduction takes place in the positive effect of government size on the growth rate by increasing the government size. Thus, according to Barro (1990), the economic growth rate first increases based on the ratio of productive government expenditure to GDP, then eventually reaches a peak and subsequently declines. This non-linear relationship, known as the "Barro curve", can be used to determine the optimum share of government expenditure.

Mourmouras and Lee (1999) integrated (Blanchard, 1985) overlapping generations model and (Barro, 1990) endogenous growth model assuming a consumer with limited life horizon and logarithmic utility function ($U(i,t) = \int_t^{\infty} Lnc(i,v)\, e^{-(\rho+\lambda)(v-t)} d_v$). In doing so they confirmed Barro's curve in a more general model. Ghosh and Mourmouras (2002), in a two-country world with the presumption of perfect capital mobility and finite horizons, indicated that the effect of government expenditure share on economic growth and trade balance improvement is similar to the Barro curve.

In another study, Kosempel (2004) and Agénor (2010) extended the model of Mourmouras and Lee (1999) and described a situation where government allocates its expenditure in two ways. First, the government spends a portion of its revenues on providing free services to consumers such as parks, museums, art galleries and healthcare which directly enter the consumer's utility function in the following CIES form:

$$u\left[c(i,t), x(i,t)\right] = \begin{cases} \dfrac{(1-\beta)\, c(i,t)^{1-\sigma} + \beta x(i,t) - 1}{1-\sigma}, & \sigma \geq 0, \sigma \neq 1, \\ (1-\beta)\, Lnc(i,t) + \beta Lnx(i,t), & \sigma = 1. \end{cases} \tag{4}$$

Second, government spends the other part on providing free services to producers such as roads, airports, railways, harbors, R&D and human forces enhancement services and which enter production functions such as that of Barro (1990, 1991) and Mourmouras and Lee (1999). However, Agénor (2010) divides government investment into infrastructure capital and spending on health, which both enter the production function. Kosempel (2004) assumes that government income is derived from proportional taxes which can be represented in the form $X(t) + G(t) = \tau Y(t)$ or $\tau_X + \tau_G = \tau$.

By solving the optimization problems of the consumer with a finite horizon ($U(i,t) = \int_t^{\infty} u\left[c(i,v), x(i,v)\right] e^{-(\rho+\lambda)(v-t)} d_v$) and the firm with an infinite horizon ($\varphi(t) = \int_0^{\infty} \left[(1-\tau)\, Y(t) - I(t) - w(t)\, L(t)\right] e^{-\int_0^t r(u) d_u} d_t$), the following equations are derived:

$$\frac{\dot{C}(t)}{C(t)} = \sigma^{-1}\left(\alpha(1-\tau)\, A^{1/\alpha} \tau_G^{(1-\alpha)/\alpha} - \delta - \rho\right) - \left(\lambda + \rho + (\sigma-1)\left(\alpha(1-\tau)\, A^{1/\alpha} \tau_G^{(1-\alpha)/\alpha} - \delta + \lambda\right)\lambda \overline{C}(t)^{-1}\right)\sigma^{-1}, \tag{5}$$

$$\frac{\dot{K}(t)}{K(t)} = \frac{1}{\alpha}\left(\alpha(1-\tau)\, A^{1/\alpha} \tau_G^{(1-\alpha)/\alpha} - \delta\right) - \delta - \overline{C}(t), \tag{6}$$

where $\overline{C}(t)$ represents the consumption–capital ratio and

$$\frac{d\left[\frac{\dot{K}(t)}{K(t)}\right]}{d\tau_x} < 0, \quad \frac{d\left[\frac{\dot{C}(t)}{C(t)}\right]}{d\tau_x} < 0, \quad \frac{d\left[\frac{\dot{K}(t)}{K(t)}\right]}{d\tau_G} \gtrless 0, \quad \frac{d\left[\frac{\dot{C}(t)}{C(t)}\right]}{d\tau_G} \gtrless 0.$$

The first two derivatives are negative while others are ambiguous. According to Kosempel (2004), the steady state growth rate is determined based on the following equation:

$$\frac{\dot{Y}(t)}{Y(t)} = \frac{\dot{C}(t)}{C(t)} = \frac{\dot{K}(t)}{K(t)}. \tag{7}$$

Therefore, an increase in τ_X leads to a decrease in the steady state growth rate. However, the change in the steady state growth rate depends on $(1-\alpha)(1-\tau_X) - \tau_G$ in the case of increasing τ_G. The steady state growth increases if the expression is positive, and vice versa. $(1-\alpha)(1-\tau_X) - \tau_G$ is negative by increasing τ_G. Thus, Kosempel (2004) concluded that the Barro curve is confirmed for the second-type expenditure, while the first-type expenditure always has negative effects on economic growth.[1]

3. Empirical studies

There are a large number of empirical studies on the relationship between government size and long-run economic growth. Ram (1986), using data for 115 developing and developed countries, concluded that time series and cross-sectional results are consistent with each other and the overall effect of government size on economic growth is positive in almost all cases.

Devarajan et al. (1996), using data from 43 developing countries, concluded that an increase in the share of current expenditure positively affected economic growth while a negative relationship was observed between the capital component of government expenditure and economic growth. In addition, governments among developing countries were shown to have misallocated public expenditure in favor of capital expenditure at the expense of current expenditure.

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1 Government expenditure can be distinguished based on whether or not it is included as a production factor in the private production function, and therefore can be called either productive or non-productive expenditure respectively. This paper focuses on productive and non-productive expenditure as per the original models of Barro (1990, 1991) Mourmouras and Lee (1999) and Kosempel (2004). However, there are other studies which focus on the effect of distortionary or non-distortionary taxation on long-run economic growth (for more details, see Mendoza et al., 1997; Kneller et al., 1999; Barro and Sala-i Martin, 2003, chapter 3).

Guseh (1997) applied the fixed effect method for 59 middle-income developing countries and found a negative effect of government size on economic growth by considering the share of total government spending in GDP as an index for government size. Ghali (1998) concluded that government size influences economic growth both directly and indirectly by focusing on government's expenditure share of GDP among 10 OECD countries.

Vedder and Gallaway (1998) calculated optimum government expenditure in the USA, Canada, Britain, Italy, Sweden and Denmark by implementing a quadratic function and found that the optimum expenditure was respectively, 17.45%, 21.3%, 20.9%, 22.23%, 19.4% and 26.1% for these countries. Gwartney et al. (1998) considered the total government expenditure to GDP proportion as an index for government size by investigating the US, 23 OECD countries and 60 less developed countries. They found government size produced a negative effect in these three cases.

Fölster and Henrekson (2001) used total tax share of GDP and total government expenditure share of GDP to measure government size. Based on the panel extreme bounds analysis, the negative effect of government size was confirmed in OECD countries only by the second measure while it was endorsed by the both measures in non-OEDC countries. Dar and Amir Khalkhali (2002) using a measure based on the ratio of government expenditure to GDP among 19 OECD countries reported that government size has a negative effect on economic growth.

Chen and Lee (2005) investigated the non-linear relationship between government expenditure and economic growth in Taiwan and found that the optimum consumption and investment expenditure were 15% and 7.3%, respectively. Loizides and Vamvoukas (2005) used the share of total expenditure in GNP as a measure of government size finding it was regarded as the 'Granger cause' of economic growth in Ireland and United Kingdom.

Bose et al. (2007), in their study on the relationship between public expenditure and economic growth among 30 developing countries using a panel data approach, concluded that government investment and spending on education had a positive effect on economic growth while it was not confirmed with respect to the effect of total current budget. Romero-Ávila and Strauch (2008), using a cointegration panel approach for 15 European countries, concluded that government consumption expenditure and direct tax have negative effects on economic growth, while the effect was positive for public investment.

Davies (2009) estimated the optimum share of government consumption and investment expenditure by maximizing the human development index among 154 high and low-income countries. Based on the results, the optimum share of consumption and investment expenditure were 17% and 13% in high-income countries, respectively. However, the optimum level was not obtained for low-income countries since consumption and investment expenditure always had positive and negative effects respectively.

De Witte and Moesen (2010) calculated the optimum government size for 23 OEDC countries using data envelopment analysis (DEA). Further, Chiou-Wei et al. (2010) investigated the non-linear effect of government size on economic growth by means of a dynamic STAR model which used the share of government expenditure in GDP as a measure for government size. The optimum size was estimated 10.8%, 11%, 15.9% and 10.8% for South Korea, Singapore, Taiwan, and Thailand, respectively.

Afonso and Furceri (2010) founded that government revenue and spending such as indirect taxes, social contributions, government consumption, subsidies, and government investment have a negative and significant effect on economic growth among OECD and EU countries. Wu et al. (2010) found a bi-directional relationship between economic growth and government size for 182 countries in all groups except low-income countries.

Ghose and Das (2013) focused on the positive and significant role of government size on economic growth by examining the relationship between government size and economic growth among 19 emerging market economies using a panel cointegration approach and taking into account different measures for government size and economic growth.

Finally, Asimakopoulos and Karavias (2016) studied the inverted U-shaped curve relationship between government size and economic growth using a dynamic panel threshold model among 129 countries during 1980–2009 and found that 19% was the optimal government size among developing countries and 18% for developed countries.

As the panel approach is widely used in the growth literature, it is interesting to examine the non-linear effects using the panel threshold methodology and comparing them with previous studies. However, previous studies typically employed measures such as government expenditure, final consumption expenditure, investment expenditure, and taxation. For this study, final consumption expenditure, current expenditure rather than final consumption, and fixed investment expenditure were considered as the measures which are almost consistently based on Kosempel (2004)'s classification.

4. Data collection and model

In order to collect data, the 14 European OECD countries which were European Union members before 1995, were selected (other than Greece). These countries – Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom – have progressed well economically compared to other members of EU. However, the economic structures of resource endowment such as labor force and natural, physical and human capital, the financial system and economic freedoms were clearly different among some of the selected countries. In addition, there were unobservable time effects such as exogenous shocks, regional and global crises. Therefore, a two-way error component model was used for considering these differences.

Based on the theoretical literature and empirical studies, the following growth regression was determined for estimation:

$$\mathrm{GGDP}_{it} = \alpha_0 + \alpha_1 \mathrm{LAB}_{it} + \alpha_2 \mathrm{INV}_{it} + \alpha_3 \mathrm{EXP}_{it} + \alpha_4 \mathrm{IMP}_{it} + \alpha_5 \mathrm{GOV}_{it} + u_{it}, \tag{8}$$

Table 1
Descriptive statistics for the variables.

Variable	Minimum	Mean	Median	Maximum	Std. Dev.
GGDP	−8.27	1.97	1.99	10.78	2.61
LAB	−2.00	0.90	0.74	5.79	1.11
INV	14.54	21.37	21.42	31.05	2.88
INVP	12.07	18.04	18.01	26.73	2.69
EXP	−20.09	4.74	4.70	23.07	5.70
IMP	−18.31	4.66	5.42	27.51	5.97
FCE	14.30	20.62	20.04	28.06	3.18
OCE	12.01	22.65	23.23	31.77	4.12
GFCF	1.53	3.33	3.48	5.57	0.89

where GGDP represents the annual growth rate of real GDP, LAB indicates the growth rate of working-age population (e.g., Solow, 1957; Barro and Lee, 1994; Sala-i Martin, 1997), INV is the gross fixed investment proportion to GDP as a substitute for the saving rate (e.g., Solow, 1956, 1957; Phelps, 1961; Mankiw et al., 1992), EXP and IMP are regarded as the growth rate of exports and imports of goods and services, respectively (Balassa, 1978; McCombie, 1985; Ram, 1985, 1987; Salehi Esfahani, 1991; Levine and Renelt, 1992; Serletis, 1992; Bahmani-Oskooee and Alse, 1993; Baharumshah and Rashid, 1999; Ramos, 2001; Alam, 2003; Awokuse, 2007; Parida and Sahoo, 2007; Bal and Rath, 2014; Vianna, 2016). Finally, GOV represents government size which is defined as the share of government spending in the GDP. All the annual growth rates are approximated by first differencing the logarithms of the selected variables. The data are based on the AMECO data set.

Total government expenditure is divided into current and capital expenditure, and current expenditure to final consumption expenditure and other current expenditure. Government expenditure is the final consumption expenditure for providing goods and services. The second part is related to social transfers (except those provided for households via market producers and etc.). Capital expenditure includes gross government fixed capital formation—that is, tangible properties such as infrastructure and intangible properties such as computer software as well as other capital expenditure such as change in inventories of the government sector, precious stones and metals.

Therefore, government size can be regarded as the final consumption expenditure proportion of GDP (FCE), current expenditure other than the final consumption proportion of GDP (OCE) or gross fixed capital formation of the government's proportion of GDP (GFCF). Based on Eq. (8), three models are considered based on FCE, OCE and GFCF, separately. In addition, each model is estimated with and without the growth rate of imports. Since there is multicollinearity between GFCF and fixed government investment, INV is replaced by the ratio of private fixed investment to GDP (INVP) in the model with GFCF. Table 1 displays a summary of descriptive statistics.

5. Threshold method

As discussed earlier, the government effect on economic growth may be non-linear (as for the Barro curve) and can be estimated using the panel threshold method suggested by Hansen (1999). The panel threshold approach leads to more reliable results than cross-sectional and time-series data models, and through which we can test the existence and significance of the threshold.

In general, the regression with J thresholds can be represented as follows:

$$\begin{aligned}\mathrm{GGDP}_{it} &= \alpha_1\mathrm{LAB}_{it} + \alpha_2\mathrm{INV}_{it} + \alpha_3\mathrm{EXP}_{it} + \alpha_4\mathrm{IMP}_{it} + (\delta_1 + \beta_1\mathrm{GOV}_{it})\,.\mathrm{I}(\mathrm{GOV}_{it}\\ &\quad \le \gamma_1) + \sum_{j=2}^{J}(\delta_j + \beta_j\mathrm{GOV}_{it}).\mathrm{I}(\gamma_{j-1} < \mathrm{GOV}_{it} \le \gamma_j) + (\delta_{J+1}\\ &\quad + \beta_{J+1}\mathrm{GOV}_{it}).\mathrm{I}(\mathrm{GOV}_{it} > \gamma_J) + u_{it},\end{aligned} \tag{9}$$

where $I(\bullet)$ indicates an index function and γ parameters represent thresholds. Disturbances are defined as $u_{it} = \mu_i+\lambda_t+v_{it}$, where μ_i is regarded as the unobservable country-specific effect such as social and political structures, and abundant natural resources, λ_t displays the unobservable time-specific effect such as exogenous shocks, regional and global crises.

Chan (1993) and Hansen (1999) suggested minimizing the sum of squared residuals obtained from a consistent estimation. For simplicity, it is assumed that thresholds are estimated from the smallest to largest:

$$\begin{aligned}\hat{\gamma}_1 &= \operatorname{argmin} S_1(\gamma_1),\\ \hat{\gamma}_2 &= \operatorname{argmin} S_2(\gamma_2|\hat{\gamma}_1),\\ &\ \vdots\\ \hat{\gamma}_J &= \operatorname{argmin} S_J(\gamma_J|\hat{\gamma}_1,\ldots,\hat{\gamma}_{J-1}).\end{aligned} \tag{10}$$

Table 2
Results of panel unit root tests.

Test	LLC		IPS		ADF-Fisher		PP-Fisher	
	INT	Trend	INT	Trend	INT	Trend	INT	Trend
GGDP	−6.73***	−8.27***	−4.68***	−5.92***	70.08***	85.12***	90.17***	151.08***
LAB	−5.39***	−5.69***	−4.91***	−4.59***	76.37***	68.90***	86.46***	81.29***
INV	−2.19**	−2.88***	−0.97	−1.35	30.66	37.33	18.42	23.17
INVP	−1.85**	−3.18***	−0.74	−1.72**	29.29	42.40**	20.57	24.87
EXP	−8.23***	−7.68***	−6.47***	−5.60***	94.08***	80.77***	145.17***	184.95***
IMP	−6.20***	−5.69***	−5.37***	−5.11***	79.53***	76.60***	125.10***	182.92***
FCE	−1.71**	−3.20***	−0.13	−1.28	23.45	37.80	15.59	17.90
OCE	−3.93***	−5.22***	−2.37***	−2.48***	53.77***	46.52**	236.52***	33.60
GFCF	−0.39	−1.61	−1.61**	−1.46	40.68**	33.14	41.31**	45.79**

Note: *** and ** represents the significance level of 1% and 5%, respectively.

According to Eq. (9), the presence of threshold(s) are shown as below:

$$\begin{aligned}
&\gamma_1 : H_0^1 : \beta_1 = \beta_2, \qquad H_1^1 : \beta_1 \neq \beta_2,\\
&\gamma_2 : H_0^2 : \beta_2 = \beta_3, \qquad H_1^2 : \beta_2 \neq \beta_3,\\
&\qquad\vdots\\
&\gamma_J : H_0^J : \beta_J = \beta_{J+1}, \quad H_1^J : \beta_J \neq \beta_{J+1}.
\end{aligned} \tag{11}$$

These hypotheses are tested by F_i:

$$\begin{aligned}
F_1 &= \frac{S_0 - S_1(\hat{\gamma}_1)}{\hat{\sigma}_1^2},\\
F_2 &= \frac{S_1(\hat{\gamma}_1) - S_2(\hat{\gamma}_2|\hat{\gamma}_1)}{\hat{\sigma}_2^2},\\
&\vdots\\
F_J &= \frac{S_{J-1}(\hat{\gamma}_{J-1}|\hat{\gamma}_1,\ldots,\hat{\gamma}_{J-2}) - S_J(\hat{\gamma}_J|\hat{\gamma}_1,\ldots,\hat{\gamma}_{J-1})}{\hat{\sigma}_J^2},
\end{aligned} \tag{12}$$

where S_0 represents the residuals sum of squares of the regression. If the jth null hypothesis is not rejected, the threshold of γ_j is insignificant and the model has only thresholds relating to $\{\gamma_1, \gamma_2, \ldots, \gamma_{j-1}\}$. However, Hansen (1996) demonstrated that the F_i distribution is non-standard relying on the sample moments and hence the critical values cannot be tabulated.

Thus, the bootstrap procedure should be used following (Hansen, 1997, 1999, 2000). First, the coefficients are estimated through minimizing the sample residuals sum of squares. Then, a new sample is produced by the residuals' distribution under the null hypothesis, by which, the coefficients are estimated under the null and alternative hypotheses and the simulated F_i statistics is obtained. The process is repeated and the p-value is calculated based on the number of simulated statistics which exceeds the actual estimation of F_i.

6. Empirical results

6.1. Estimations

The panel unit root tests were first performed for LLC (Levin et al., 2002), IPS (Im et al., 2003), ADF-Fisher and PP-Fisher (Maddala and Wu, 1999; Choi, 2001). Based on the results, the null hypothesis of the unit root was rejected for all variables (Table 2).

Breusch and Pagan (1980), Honda (1985), and Moulton and Randolph (1989) developed the Lagrange multiplier test in order to determine the types of unobservable individual and time effects. In addition, Moulton and Randolph (1989) indicated that the ANOVA F-test can be used for specifying the effects in the one-way error component model. Based on the null hypothesis of the above tests, there are no individual or time effects. As shown in Table 3, the null hypothesis is rejected in all the specifications (with and without the growth rate of imports) and the error terms include both the country-specific and time-specific effects (μ_i and λ_t).

Then the Hausman (1978) test was performed to select the fixed or random effects. Based on the null hypothesis, there is no dependency between explanatory variables and disturbances. Both LSDV and the GLS estimators are consistent under the null hypothesis although the latter is more efficient. In fact, the GLS estimator is consistent and asymptotically efficient under H_0. However, the fixed effects should be used if the null hypothesis is rejected. Based on the results, the null hypothesis

Table 3
Individual- and time-effects tests.

Model	FCE		OCE		GFCF	
Specification	First	Second	First	Second	First	Second
Honda LM						
Individual	2.83***	3.53***	2.01**	2.77***	1.50	2.16**
Time	4.62***	5.89***	5.18***	6.49***	5.15***	6.31***
Standardized LM						
Individual	3.65***	4.43***	2.73***	3.57***	2.18**	2.91***
Time	5.22***	6.52***	5.82***	7.17***	5.78***	6.96***
Breusch–Pagan LM						
Individual	8.00***	12.43***	4.02**	7.66***	2.24	4.66**
Time	21.38***	34.75***	26.80***	42.16***	26.54***	39.86***
ANOVA F						
Individual	5.24***	7.07***	2.19***	2.76***	2.23***	2.93***
Time	3.78***	5.19***	4.16***	5.70***	4.02***	5.40***
Hausman						
Individual	25.23***	36.01***	14.44**	9.99**	12.79**	10.84**
Time	15.22***	18.08***	23.63***	30.96***	19.39***	24.35***

Note: *** and ** represents the significance level of 1% and 5%, respectively.

Table 4
Threshold test.

Model	FCE		OCE		GFCF	
Specification	First	Second	First	Second	First	Second
F_1	351.83***	352.8***	114.80	110.86	118.52**	129.36**
p-value	0.008	0.004	0.106	0.1030	0.033	0.023
Critical values						
99%	337.53	291.32	248.89	262.38	155.21	124.12
95%	202.65	192.75	153.86	153.42	106.02	35.66
F_2	157.83	167.79**			42.18	54.45
p-value	0.052	0.027			0.211	0.143
Critical values						
99%	262.45	216.51			127.40	131.31
95%	161.89	140.44			83.58	84.55
Optimum size	16.63	16.63			2.31	2.31

Note: *** and ** represents the significance level of 1% and 5%, respectively.

is rejected in all the specifications, and accordingly the two-way error component regression model with fixed effects is regarded as appropriate (Table 3).

Table 4 displays the results of testing the existence of thresholds. The bootstrap is repeated for 10 000 times for each model, upon which the critical and *p*-values are calculated. One threshold is confirmed for final consumption expenditure (FCE) and government gross fixed capital formation expenditure (GFCF) although no threshold was verified for other current expenditure (OCE).[2] Total expenditure includes both current and capital expenditure. The optimum share of final consumption expenditure (FCE) and the optimum share of government fixed investment (GFCF) were estimated to be 16.63% and 2.31% respectively. Thus, the sum of the optimum share of expenditure is 18.94% (Table 4).

Table 5 represents the estimation of FCE and GFCE regressions with one threshold as well as the regression of OCE based on the linear model. However, based on the literature, government size is affected by economic growth with empirical studies finding evidence in favor of the endogeneity of government expenditure (Slemrod et al., 1995; Conte and Darrat, 1988; Agell et al., 2006; Afonso and Furceri, 2010; Wu et al., 2010; Thamae, 2013; Christie, 2014; Asimakopoulos and Karavias, 2016). Therefore, the growth regressions are estimated using the generalized method of moments (GMM) estimator, which allows for the endogenous nature of government size (Table 5). Arellano and Bond (1991) suggest the use of the lagged endogenous variables as instruments for the current values. In the present study, 2–4 lags of the endogenous variables were used as the instrument, and the regressions were estimated using the GMM estimators of Arellano and Bover (1995) and Seo and Shin (2016).

The results of LS and GMM estimators are consistent and no considerable difference was observed. Generally, the coefficients were statistically significant and were correctly signed. In all the specifications except one, the growth rate of labor has a significant and positive impact on the growth rate (α_1). Based on LS, an increase in the labor growth rate leads to a 0.3–0.5% increase in economic growth. However, the GMM estimators are smaller and more stable since an increase in the labor growth rate results in enhancing economic growth by 0.06–0.15%.

[2] In the final consumption expenditure model, the second threshold is confirmed although the direction is unchanged and merely intensifies the changes slightly.

Table 5
The results of threshold regression.

Model	FCE		OCE		GFCF	
Specification	First	Second	First	Second	First	Second
OLS						
α_1	0.316***	0.332***	0.403***	0.435***	0.462***	0.517***
	(0.098)	(0.100)	(0.101)	(0.103)	(0.101)	(0.104)
α_2	0.040	0.065	−0.029	−0.022	0.036	0.078
	(0.045)	(0.046)	(0.052)	(0.053)	(0.054)	(0.054)
α_3	0.092***	0.157***	0.092***	0.165***	0.082**	0.159***
	(0.032)	(0.027)	(0.032)	(0.027)	(0.033)	(0.028)
α_4	0.098***		0.111***		0.122***	
	(0.028)		(0.029)		(0.029)	
δ_1	10.738**	11.677**	4.852**	5.631***	−5.743**	−6.057**
	(5.255)	(5.378)	(1.975)	(2.025)	(2.446)	(2.533)
δ_2	5.413***	6.519***			−0.185	−0.670
	(1.926)	(1.947)			(1.051)	(1.081)
ß$_1$	−0.502	−0.562	−0.159***	−0.194***	2.910**	2.854**
	(0.318)	(0.325)	(0.052)	(0.053)	(1.158)	(1.199)
ß$_2$	−0.276***	−0.349***			0.015	−0.031
	(0.087)	(0.087)			(0.179)	(0.185)
Adj. $\bar{R}^2$	0.848	0.840	0.833	0.823	0.830	0.818
Obs	266	266	266	266	266	266
GMM						
GGDP$_{-1}$	0.197***	0.270***	0.273***	0.260***	0.319***	0.348***
	(0.049)	(0.042)	(0.041)	(0.029)	(0.038)	(0.025)
α_1	0.123**	0.062	0.114**	0.111***	0.143***	0.151***
	(0.051)	(0.049)	(0.050)	(0.034)	(0.055)	(0.046)
α_2	0.082***	0.099***	−0.031	−0.042*	0.090***	0.112***
	(0.023)	(0.024)	(0.029)	(0.024)	(0.026)	(0.022)
α_3	0.077***	0.116***	0.080***	0.129***	0.069***	0.111***
	(0.016)	(0.015)	(0.017)	(0.010)	(0.015)	(0.010)
α_4	0.074***		0.081***		0.076***	
	(0.014)		(0.016)		(0.015)	
ß$_1$	−0.784***	−0.692***	−0.200***	−0.278***	1.550***	1.381***
	(0.209)	(0.220)	(0.041)	(0.033)	(0.450)	(0.327)
ß$_2$	−0.295***	−0.365***			−0.099	−0.131
	(0.056)	(0.049)			(0.121)	(0.097)
Arellano–Bond						
AR(1)	−6.509***	−6.001***	−6.266***	−5.865***	−6.659***	−6.362***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
AR(2)	−1.378	1.576	−1.522	−1.640	−1.442	−1.604
	(0.168)	(0.115)	(0.128)	(0.101)	(0.149)	(0.109)
J-statistic	146.948	140.118	142.970	161.675	153.140	155.286
	(0.109)	(0.201)	(0.105)	(0.177)	(0.136)	(0.112)
Obs	238	238	238	238	238	238

Note: ***, ** , and * represents the significance level of 1%, 5%, and 10%, respectively. Standard errors and p-values are in parentheses for the coefficients and the Arellano–Bond and Sargan tests, respectively.

The effect of the investment to production ratio on economic growth is strongly significant and positive for the GMM estimators and for FCE and GFCF. An increase in the ratio of investment leads to a 0.1% increase in economic growth. However, investment has no statistically significant effect on economic growth (α_2) in the other specifications. Some studies indicated a negative effect of investment, especially for the time series data among the developed countries. For example, Sala-i Martin (1997a, b) concluded that the ratio of investment to production has no significant effect on the growth regressions (see Dulleck and Foster, 2008).

In all the specifications, the growth rate of exports and imports has a significant and positive impact on the growth rate (α_3 and α_4). The results of LS and GMM are identical. In other words, an increase in the growth rate of exports and imports leads to a 0.1% increase in economic growth.

The lag of economic growth is statistically significant in GMM which justifies the dynamic estimations. The estimated coefficients are positive (Easterly et al., 1993; Alesina et al., 1996; Uddin et al., 2017).

Arellano and Bond (1991) suggested the use of the Sargan test in order to validate the instruments. Based on the null hypothesis, the instruments are exogenous, which is not rejected in any of the regressions. The Arellano and Bond (1991) estimator was also utilized to test the residual autocorrelation. As observed in Table 5, the null hypothesis related to no first-order autocorrelation was rejected while the second-order autocorrelation was not confirmed. The Arellano–Bond test uses differenced residuals. Therefore, the first-order autocorrelation of the differenced error term is expected even if the error term in levels is uncorrelated because $cov(u_{it} - u_{i,t-1}, u_{i,t-1} - u_{i,t-2}) \neq 0$. However, the test for the second-order serial correlation is more important since it may detect autocorrelation in levels. Therefore, confirming the second-order autocorrelation results in rejecting the appropriateness of the proposed instruments.

In both the LS and GMM estimators, the final consumption expenditure has a negative and significant effect on the growth after the optimal size of 16.63% (β_2). The effect of final consumption expenditure is not significant before the optimal size of 16.63% in LS while it is statistically significant in the GMM estimator (β_1). However, as shown in Table 6, the estimated β_1 in GMM is fragile.

Current expenditure such as spending on education, health and R&D are usually regarded as growth enhancing expenditure. Some studies have indicated that public investment in education and health can increase the level of human capital, which is regarded as a main source of long-run economic growth (Lucas, 1988; Bloom et al., 2000, 2007, 2010; Acemoglu and Johnson, 2007). In addition, Romer (1990a) emphasized the role of research and development expenditure. Therefore, expansionary fiscal expenditure of up to 16.6% can stimulate an economy without having any negative effect on long-run growth (Bose et al., 2007; Falk, 2007; Baldacci et al., 2008; Annabi et al., 2011; Benos and Zotou, 2014; Glewwe et al., 2014; Daniel and Gao, 2015; Hong, 2016).

Based on the LS and GMM procedures, after passing the optimal size of 16.63%, a 1% increase in FCE produces a 0.3% decrease in economic growth. In other words, after the optimum level, a decrease in FCE can have a meaningful positive effect on economic growth.

A number of reasons can be attributed to the negative effect of consumption expenditure on economic growth where it passes the threshold level. Financing government expenditure via taxes and borrowing may crowd out private investment. In addition, larger government size is related to centralization and bureaucracy which decrease creativity and distorts resource allocation. Accordingly, the economic growth induced by enhancing expenditure is disturbed or slowed down (Gwartney et al., 1998; Ram, 1986). Hence, Bergh and Henrekson (2011) show that an economy can experience higher growth through increasing the size of the government if social trust levels are improved and market-friendly policies are implemented in other areas.

On the other hand, some studies have indicated that the positive effect of productive consumption expenditure on economic growth can be reversed. For example, Sylwester (2000) demonstrated that education expenditure can positively influence economic growth in the future, even though the current impact is negative. However financing education expenditure by government can result in the creation of inefficiency and market distortions thereby decreasing the economic growth. Further, according to Kancs and Siliverstovs (2016), the effect of R&D expenditure on growth is positively significant only after accumulating a certain critical mass of knowledge.

As shown in Table 4, no optimum size was observed for other current expenditure—such as social transfers and subsides. Other current expenditure negatively affected the growth rate with a 1% decrease leading to 0.16–0.27% higher economic growth (β_1). Since the effect of OCE on economic growth is always negative, these expenditures are likely to be mostly unproductive. The result is consistent with the findings of Devarajan et al. (1996), Afonso and Furceri (2010), and Bergh and Henrekson (2011).

The optimum share of gross fixed capital formation (GFCF) was estimated to be 2.3%. An increase in fixed investment expenditure has a positive effect on growth prior to reaching the 2.3% threshold. An increase in the government fixed investment share leads to 1.5%–3% increase in economic growth (β_1). The result is in line with the study of Barro (1990), Kosempel (2004), Bose et al. (2007), and Agénor (2010). However, based on both LS and GMM estimators, there is no positive effect when the share of government investment is passed the optimum level of 2.3% (β_2). Thus, it can become unproductive when productive expenditure is excessively used. For example, public investment will become less productive when it is allocated to inefficient projects, or replaces the private investment. The results are consistent with the study of Devarajan et al. (1996) in which all the standard candidates for productive expenditure such as capital, transport and communication, health, and education played either a negative or an insignificant role in economic growth given productive expenditure may be unproductive after passing a threshold value.

Finally, Fig. 1 represents the final consumption and fixed investment expenditure (GDP%) for 14 European countries during 2010–2014. In Luxembourg and Ireland, final consumption expenditure is almost equal to the optimum level. The final consumption expenditure as a share of GDP is 19%–20% in Austria, France, Germany, Italy, Portugal, Spain, and United Kingdom. The consumption expenditure share of GDP is remarkably larger than that of the threshold level (approximately 9%) in Belgium, Denmark, France, Finland, Netherlands, and Sweden. Therefore, since final consumption expenditure as a share of GDP play a negative role after passing 17%, the former above mentioned group of countries can follow a strategy for reducing government size in order to achieve higher economic growth.

Government capital expenditure is approximately equal to the optimum level of 2.3% in Belgium, Germany, Ireland, Denmark, Finland, Luxembourg, Netherlands, and Sweden while it equals to 2.5 to 3% in the other countries. The fixed capital share has no positive effect on the growth once the optimum level is surpassed. Generally, all the countries except Luxembourg and Ireland can experience higher economic growth through smaller government size.

6.2. Robustness tests

In this section, the robustness of the regression results are presented and the models are re-estimated using different specifications and methods.

The growth regression includes human capital and openness. The growth of human capital (GH) is added to the regression, as measured by the growth rate of average life expectancy. Higher life expectancy is generally associated with lower morbidity and better health status for the labor force and population. Changes in life expectancy can influence economic

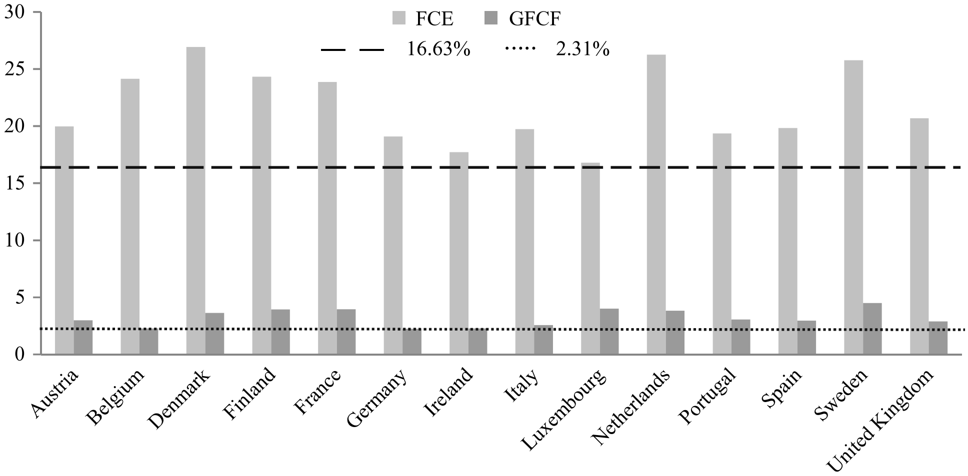

Fig. 1. Mean of expenditure among European countries during 2010–2014.

growth through various mechanisms. For example, an increase in life expectancy induces higher productivity of workers, longer working life and higher saving rates. A longer life expectancy may lead to more incentives to invest in education, which increases the length of time by which the return to human capital investment is received (Romer, 1990b; Bloom et al., 2000; Bloom and Canning, 2004; Echevarría and Iza, 2006; Bloom et al., 2007; Acemoglu and Johnson, 2007; Bloom et al., 2010; Cervellati and Sunde, 2011; Desbordes, 2011; Kunze, 2014).

In addition, the openness index (OPN) – the ratio of exports and imports to GDP – is regarded as a substitute for the growth rates of exports and imports in the growth regression (Levine and Renelt, 1992; Sachs and Warner, 1995; Harrison, 1996; Wacziarg and Welch, 2008). The index is used to investigate whether the substitution of the openness for growth rates of exports and imports leads to an unchanged threshold and a non-linear relationship between economic growth and government size.

In the second stage, another robustness check is used to test for endogeneity of right-hand-side variables. As previously discussed, some studies found some evidence for the endogeneity of government size (Slemrod et al., 1995; Conte and Darrat, 1988; Agell et al., 2006; Afonso and Furceri, 2010; Wu et al., 2010; Thamae, 2013; Christie, 2014; Asimakopoulos and Karavias, 2016). In this case, the bias of estimators is eliminated using two-stage least squares (2SLS) and lagged values of government size as the instruments (Caner and Hansen, 2004).

In addition, the growth regression can be considered as a dynamic panel with the lagged value of the economic growth. Therefore, GMM is employed to evaluate the endogeneity of government size and economic growth (Arellano and Bover, 1995; Seo and Shin, 2016). Here, as displayed in Table 5, dynamic regressions were estimated using the full instruments set and 2SLS weights instead of the restricted set and the White diagonal weights.

Table 6 represents a summary of results. Generally, the significance of the coefficients of explanatory variables remains robust for alternative specifications. However, the human capital growth and openness indices are statistically insignificant. Given the additional control variables cannot improve the growth regression, these specifications are taken to be inappropriate.

The optimum value of final consumption expenditure is robust in respect of the various control variables and the 2SLS method although the robustness results are less clear-cut in the case of the GMM method. Based on LS and GMM approaches, the linear and negative effect of other consumption expenditure on economic growth is unequivocally robust. In the case of 2SLS, a threshold was statistically confirmed while the coefficient of OCE became statistically insignificant when the model is estimated by either the linear or non-linear model. Finally, the results for the fixed investment expenditure as a share of GDP (GFCF) remain completely robust.

7. Conclusion

The literature on growth indicates a non-linear relationship between economic growth and government expenditure in the form of an inverted U-shaped curve which is known as the "Barro curve". This is used to determine the optimum share of government expenditure. The purpose of this paper is to examine whether the Barro curve characterizes the economies of 14 European countries.

Based on the literature, previous studies have only focused on final consumption expenditure. Therefore the present paper seeks to evaluate final consumption expenditure (FCE), other current expenditure (OCE), and fixed investment expenditure (GFCF). As our sample countries are limited to those which are relatively developed, homogeneous and members of the

Table 6
Robustness results.

Model	LS		2SLS		GMM	
Specification	GH, OPN	GH	GX, GM	GX	GX, GM	GX
FCE						
ß$_1$	−1.308***	−0.497	−0.730	−0.763	−0.555	−0.569
	(0.212)	(0.318)	(0.499)	(0.510)	(0.348)	(0.000)
ß$_2$	−0.261***	−0.272***	−0.175*	−0.270***	−0.288***	−0.297***
	(0.101)	(0.088)	(0.101)	(0.099)	(0.096)	(0.094)
Threshold	18.62	16.63	16.62	16.62	16.62	16.62
$F_{Threshold}$	423.299***	352.934**	221.579***	120.064*	250.979	237.118
	(0.000)	(0.020)	(0.000)	(0.060)	(0.230)	(0.480)
J-statistic					190.511	201.347
					(0.231)	(0.273)
OCE						
ß$_1$	−0.221***	−0.157***	−0.012	−0.022	−0.222***	−0.249***
	(0.057)	(0.053)	(0.058)	(0.059)	(0.070)	(0.001)
ß$_2$						
Threshold						
$F_{Threshold}$	116.309*	118.129	166.795**	156.656*	137.083	130.856
	(0.050)	(0.130)	(0.030)	(0.050)	(0.690)	(0.850)
J-statistic					186.050	186.562
					(0.236)	(0.228)
GFCF						
ß$_1$	3.443***	2.686**	−2.770	−4.627*	1.631	1.393
	(1.274)	(1.164)	(1.781)	(2.525)	(1.177)	(1.199)
ß$_2$	−0.226	−0.007	−0.846**	−1.163***	−0.150	−0.253
	(0.213)	(0.196)	(0.371)	(0.392)	(0.213)	(0.216)
Threshold	2.310	2.310	2.360	2.360	2.310	2.310
$F_{Threshold}$	187.577***	119.274**	64.803*	120.107**	68.258*	68.286*
	(0.000)	(0.020)	(0.050)	(0.020)	(0.090)	(0.070)
J-statistic					205.670	206.214
					(0.193)	(0.186)

Note: ***, ** , and * represents the significance level of 1%, 5%, and 10%, respectively. Standard errors and p-values are in parentheses for the coefficients and the Arellano–Bond and Sargan tests, respectively.

European Union, it is reasonable to assume that the effect and optimum size of expenditure becomes almost identical and to consider the minor unobservable effects by way of the panel threshold approach.

The results indicate that the existence of the Barro curve (1990) is confirmed though the measurement of final consumption expenditure (FCE) and fixed investment expenditure (GFCF). In addition, other current expenditure (OCE) is shown to negatively influence economic growth. According to Kosempel (2004), the Barro curve is only confirmed for the expenditure which provides services for the private sector by way of production activities. However, the expenditure which provides services for consumers always has a negative effect on economic growth.

A budget includes current expenditure (FCE and OCE) and capital expenditure (GFCF) in the standard classification and is used in empirical studies although it is not exactly in agreement with Kosempel's classification based on consumers and producers. Capital expenditure is mainly related to producers, although some expenditure – such as on parks or museums – is not necessarily regarded as productive. In addition, FCE includes productive expenditure such as that on education and health for the labor force. Therefore, non-linear effects can be confirmed for both current and capital expenditure, and the Barro curve can be confirmed for FCE and GFCF. However, it seems that OCE mainly affects consumers due to the negative effect on economic growth. The results are consistent with the study of Devarajan et al. (1996).

The optimum level of FCE is estimated to be 16.6% which is approximately equal to the 17% and 18% optimum levels of the studies carried out by Davies (2009), and Asimakopoulos and Karavias (2016) among developed countries, respectively, as well as the 15% and 16% reported by Chen and Lee (2005) and Chiou-Wei et al. (2010) for Taiwan. However, the threshold size was larger than the findings of Chiou-Wei et al. (2010) for Korea, Singapore and Thailand (11%).

The optimum level of fixed capital formation expenditure was calculated to be 2.3% - smaller than 13% reported by Davies (2009) for high-income countries and the 7.3% Chen and Lee (2005) found in the case of Taiwan. Based on these results, the sum of these expenditures (FCE+GFCF) is approximately 19%, which is smaller than the 30%, 23% and 19.5%–26% reported by Davies (2009), Chen and Lee (2005), and Vedder and Gallaway (1998), respectively. Therefore, it can be concluded that the optimal size may depend on the level of income.

Finally, the non-linear relationship between government size and economic growth can explain why some empirical studies (e.g., Ram, 1986; Bose et al., 2007; Romero-Ávila and Strauch, 2008; Ghose and Das, 2013) estimate a positive effect while some other studies estimate a negative effect (e.g., Guseh, 1997; Gwartney et al., 1998; Fölster and Henrekson, 2001; Dar and Amir Khalkhali, 2002; Afonso and Furceri, 2010).

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