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Code availability

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Authors' contributions

Conceptualization: TYG; Methodology: TYG; Formal analysis and investigation: TYG; Writing - original draft preparation: TYG; Writing - review and editing: TYG; Project administration: LD; Software: TYB; Supervision: LD.

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Abstract

Public spending is a part of the fiscal policy and one of the government's main tools to implement its economic policy. With government spending still on the rise in many economies, and the different economic growth levels, especially in low and middle economies, the debate on whether government spending has a positive, negative or neutral impact on economic growth is still raging nowadays. So, in this analysis, we attempt to contribute to this issue by shedding light on this relationship in the case of low, middle, and high-income countries. In so doing, we extend the previous work of Devarajan et al. (1996) and Chu et al. (2020) by considering the nonlinear relationship between disaggregated public spending and economic growth. We also pay attention to the role of public spending on environmental protection, political stability, control of corruption, and the 2008 financial crisis, on economic growth. To reach our objectives, we examine 13 high-income countries and 22 low to middle-income countries for the period 1993-2018 through four estimations techniques: the fixed-effects approach; the pooled standard errors Driscoll-Kraay (1998), the panel feasible generalized least squares, and the difference GMM with orthogonal deviations.

Keywords: Public Spending, Economic Growth, Cross-dependence, Low-Income countries, Middle-Income Countries, High-Income countries

JEL code: H5, C2, O5

1. Introduction

Public spending can be defined as consumption, investment, and transfer payments that enable the government to produce goods and services to realize its policy. Taxes and public borrowing mainly finance this spending. Taxes can be direct and indirect, while borrowings imply selling government bonds. The combination of public spending and taxation constitutes government fiscal policy. This policy is called expansionary when there is an increase in spending and/or a decrease in taxation, and contractionary in the case of a reduction of government spending and/or an increase in taxation. This policy is used by the government as an instrument to influence economic growth, as suggested by Keynes (1936) in his theory (so-called Keynesian theory).

Besides, according to the World Bank's Development report 2017, public spending and taxes are policy instruments used to manage development outcomes such as security, growth, and equity. So, public spending affects economic growth, and this influence can be positive, negative, or neutral, as noted by certain authors like Ram (1986), Landau (1986), Scully (1989), and Diamond (1989). This effect can also be bidirectional as economic growth can lead to changes in either aggregate public spending (Wagner's Law) or some of its components (through changes in the demand for certain public services).

As all economies' objective is its development through a positive and constant economic growth, a variety of empirical studies, based on time-series or cross-country data, have been aimed at estimating the specific contribution of public spending to economic growth. The major obstacles encountered in these studies include the difficulties involved in valuing public sector outputs, estimating the impact of public expenditure financing separately, and measuring the effects of other factors on economic growth. Some studies of the relationship between aggregated public spending and economic growth are sensitive to small changes in the model specification (Levine and Renelt, 1992). Certain relates total public spending to economic growth while others focus on the relationship between specific spending components, such as health, education, defense, and economic growth.

In this analysis, we attempt to answer to the question about the types of public spending that significantly impact economic growth. We focus on low, middle, and high-income countries because; we assume that a given starting level of income can influence economic variables. In so doing, we contribute to the literature about the link between public spending and economic growth by extending the work of Devarajan et al. (1996) and Chu et al. (2020).

In effect, after examining the impact of aggregated public spending on economic growth, we consider, on contrary of these authors the nonlinear relationship between disaggregated public spending and economic growth in low, middle and high-income countries. We also pay attention to the role of public spending on environmental protection, political stability, control of corruption, and the 2008 world's financial crisis in this relationship.

This work is organized as follows: the first part is about the study introduction. Section two concerns the literature review, and is about the different variables used in this analysis — the next section details materials and methods used in this work. Section four shows the results and discussions for the various analysis methods used, and section five is for the conclusion and results policy implications.

2. Literature Review

Many theories and empirical analysis have been developed across the years to understand the nature, if any, of the relationship between public spending and economic growth. Considering the importance of this issue, we attempt in this section to shed light on some main contributions to this question.

Keynes's (1936) considered that Government action is important in economic activity. For him, the new spending coming from the public investment will contribute to creating activity, hence reducing unemployment and restore corporate profit margins. He rejected the criticism concerning the crowding-out effect of the public investment and considered fiscal policy a crucial determinant of economic activity. However, the question of the components of public expenditure remains less explicit since it only mentions the role of loan funds expenditure (which enrich the community) in his analysis. According to Kalecki (1943), Public authorities can, directly and indirectly, increase the employment level through the increase of spending. In effect, if Government undertakes capital expenditure (schools, hospitals, roads) or subsides household consumption (allowances, indirect taxes, necessities), and if the public spending is financed by borrowing only, then the effective demand for goods and services could rise to the point of achieving the objective of full employment. Through the increase of production and employment, public spending benefits workers and entrepreneurs as it does not lead to additional taxes.

Samuelson (1958) deals with the difficulties linked to the theory of public spending and those related to political decision-making. Its analysis is made through various hypotheses: Government must focus on the production of collective goods and maximize the function of social well-being. For him, the Government has multiple functions. Firstly, it must increase economic activity efficiency by promoting competition and providing public goods. Secondly, it encourages equity through redistribution using the mechanism of public spending and taxes. Thirdly, it contributes to macroeconomic stability and economic growth through fiscal policy and monetary regulation (reducing unemployment and inflation). Governments must constrain citizens to pay taxes, respect regulations and consume public goods and services to reach this objective. That is only possible in a situation of Government intervention. This point of view allows for the study of the effect of the composition of public spending on growth. This study, developed during the 1980s by some authors like Romer (1986) and Barro (1990) deals with the importance of public spending by considering it as input. For these authors (endogenous growth economists), if a part of public expenditure can be qualified as unproductive, several public spending functions can directly or indirectly contribute to productivity and the creation of externalities. These functions include infrastructure, education, health, property rights.

Romer (1986) studied the origin of growth considering the impact of public investment, particularly public investment in capital. Barro (1990) contributed to his work by assuming the role of public infrastructures such as roads, bridges, electricity, and security as growth determinants. In his work, Barro (1990) considers that the factors provided by Government, sources of endogenous growth are in two forms: in the one hand, public expenditure is directly integrated into the household utility function, and in this case, there is an important possibility of substitution between public and private spending; in the other hand, public expenditure is introduced into the

producer production function, in this circumstances it is complementary to private spending by increasing the marginal profitability of capital.

The first type of expenditure (public consumption in empirical analysis) reduces the growth rate and the savings rate because it has no effect on private sector productivity and increases the taxation rate. The second type of expenditure (ratio of public investment to GDP) has two effects. Firstly, an increase in the tax rate, which reduces the growth rate. Secondly, an increase in public spending contributes to capital productivity, hence improve growth. The first effect dominates when the Public role is large, while it is the second when the Public action is small.

King et Rebelo (1990) estimated that public policies could significantly impact the average economic growth in an economy. Public policies encourage physical and human capital accumulation. This incentive effect is reinforced in an open economy considering access to international capital markets. So, whether it is an open or closed economy, a relatively small change in the tax rate (or public expenditure) can precipitate the economy into a long period of stagnation or decline if these policies destroy incentives favorable to growth. They conclude that public policies through the incentive effects can influence the growth rate.

For Tanzi et Zee (1997), public spending can affect the rate of economic growth through at least two ways: directly, by increasing the capital stock of the economy via, for example, public investment in infrastructure (which can be complementary to private investment); indirectly, by increasing the marginal productivity of the factors of production offered by the private sector, through spending on education, health and other services that contribute to the accumulation of human capital. With regard to the first channel, it should be noted that public capital, like any other factor of production, is subject to diminishing marginal returns. As a result, excessive public spending on infrastructure (relative to private investment) can be inefficient. On the other hand, the effect of public investment on private investment and growth may depend on the form of taxation used to finance it.

Further, authors empirically showed that public spending effects on economic growth can be positive and negative.

On one hand, Easterly et Rebelo (1993), Devarajan, Swaroop, et Zou (1996), Yasin (2000), Nubukpo (2003), Adam et Bevan (2005), Bose, Haque, et Osborn (2007), Gosh et Gregoriou (2008), Yu, Fan, et Saurkar (2009), Gemmell, Kneller, et Sanz (2015), Chu et al. (2020) found a positive relationship between public spending and economic growth.

In effect, Easterly et Rebelo (1993) using a cross-sectional approach, found that government spending on transport and communication has a positive impact on economic growth. Devarajan, Swaroop, et Zou (1996) examined public expenditure-economic growth nexus for 43 developing countries for 1970-1990. Using the OLS method to test the hypothesis that the economic impact of each type of spending could depend on the share allocated to it, they found that a 1% increase in the ratio of current public expenditure to GDP increases real GDP per capita by 0.05%.

Yasin (2000) applied fixed-effects and random-effects techniques to examine the effect of government spending on economic growth in 26 sub-Saharan African countries from 1987 to 1997. His results showed a positive relationship

between these variables. Nubukpo (2003), considering this relationship in the West African Economic and Monetary Union (WAEMU) countries for the period 1965-2000, found the same results in the long-run.

Adam et Bevan (2005), studying the relationship between public expenditure and economic growth with disaggregated public spending, found that public expenditure on health, education, infrastructure, defense, and public administration have a positive effect on economic growth. They obtained these results through the study of 45 developing countries from 1970 to 1999.

Also, considering developing countries (30 developing countries), Bose, Haque, et Osborn (2007) examined the growth effects of government expenditure over the 1970s and 1980s, focusing on disaggregated government expenditures. They concluded that the impact of public expenditure on economic growth is positive. Their results showed that public spending on education had a positive effect on economic growth at the disaggregated level, considering budget constraints and omitted variables.

Besides, Gosh et Gregoriou (2008) investigated the relationship between disaggregated government expenditure and economic growth in 15 developing countries, using the general method of moments (GMM). They found that government spending on operations and maintenance had a positive impact on economic growth.

Yu, Fan, et Saurkar (2009) concluded that public spending in human capital contributes to growth in Africa, and public spending in agriculture and education contribute to growth in Asia. They found these results after using dynamic generalized least squares to examine public spending-growth nexus in the case of 44 developing countries for the period 1980-2004. Gemmell, Kneller, et Sanz (2015) focused on a panel of 17 OECD countries for a period 1972-2008. They used the Pooled Mean Group (PMG) method to analyze the impact of aggregated and disaggregated public spending on economic growth. They found that public spending on education and infrastructure contributes to economic growth in the long-run.

Also, considering the relationship between aggregated and disaggregated public spending and economic growth, Chu et al. (2020) found a positive effect of productive government spending on growth for the studied countries. Furthermore, they found that public expenditure on education, general public services, and housing have a positive effect on economic growth for high-income countries, while expenditure on health and economic affairs have a positive impact on growth for low to-middle income countries.

On the other hand, authors like Gupta et al. (2003), Romero-Ávila et Strauch (2008), Christie (2012) and Ndambiri et al. (2012), Altunc et Aydin (2013), Lupu et al. (2018) found a negative effect of public spending on economic growth

Gupta et al. (2003), studying disaggregated public spending-growth nexus, found that current public expenditure has a negative effect on economic growth. Romero-Ávila et Strauch (2008), also examined a relationship between aggregated and disaggregated public spending and economic growth for a sample of 15 European countries from 1960 to 2001. Using a fixed-effect model, they found that public spending has a negative effect on GDP per capita

(A 1% increase reduces growth by 3.1%); and public consumption, transfers, and income from social security have a negative effect on growth.

Christie (2012) and Ndambiri et al. (2012) used different databases and econometric approaches to analyze the link between public spending and economic growth. They found a negative relationship between these two variables, studying 108 developing countries for 1971-2005, and 19 sub-Saharan countries for the period 1982-2000, respectively. Altunc et Aydin (2013) analyzed the nexus government expenditure-economic growth in three countries (Turkey, Romania, Bulgaria) for the period 1995-2011. These authors attempt to show if the link between these two variables is linear or an "inverted U" shape and determine the optimal level of government spending in the studied countries. They used the ARDL bounds testing approach to find that government spending exceeded the optimal level, hence reducing the economic growth rate. Lupu et al. (2018) considered the same topic for ten selected Central and Eastern European countries for 1995-2015. Using an ARDL estimation technique, they showed that public expenditure on defense, economic affairs, general public services, and social welfare have a negative impact on economic growth.

As seen previously, various econometric studies have attempted to show the relevance of the theory relating to fiscal policy effectiveness, particularly public expenditure. These empirical studies shed light on theoretical studies, presented a diversity and sometimes very opposite points, and give an idea of the number of theoretical and empirical approaches relating to the impact of aggregated and disaggregated public expenditures on economic growth.

Overall, these studies suggested different types of results, and based on the nature of these relationships; public expenditures are denoted productive (positive relationship) or nonproductive (negative and insignificant relationship). The next sections try to contribute to this analysis by giving another point of view to this literature.

3. Materials and Methods

3.1 Theoretical model

This analysis is based on the model developed by Devarajan, Swaroop, et Zou (1996) and Chu et al. (2020). These authors showed the difference between productive and nonproductive growth in their analysis and linked government expenditure and long-term growth through a constant elasticity of substitution (CES) as follow:

$$y = f\left(k, g_1, g_2\right) = \left[\alpha k^{-\xi} + \beta g_1^{-\xi} + \gamma g_2^{-\xi}\right]^{-1/\xi}, \quad (1)$$

Where k, private capital stock, g_1, productive government spending, g_2 nonproductive government spending. And $\alpha \succ 0,\ \beta \geq 0,\ \gamma \geq 0;\ \alpha + \beta + \gamma = 1,\ \xi \geq -1.$

The government expenditure is expressed as

$$\tau y = g_1 + g_2 = \phi\tau y + (1-\phi)\tau y \quad (2)$$

Where τ, a flat rate income tax; ϕ, the share of total government expenditure which goes toward g_1 and g_2. And $0 \le \phi \le 1$; $g_1 = \phi\tau y$; $g_2 = (1-\phi)\tau y$. τ and ϕ are considered as given. Assuming that the representative agent chooses consumption *c,* and capital *k* to maximize his welfare, we obtain:

$$U = \int_0^{\infty} u(c) e^{-\rho t} dt \quad (3)$$

With $\dot{k} = (1-\tau) y - c$ (4)

And ρ, the rate of time preference. Then, the transformation of the utility function in the isoelastic is:

$$U(c) = \frac{c^{1-\sigma} - 1}{1-\sigma} \quad (5)$$

Where the substitution of (5) into (3) and the maximization of (1); (2) and (4) permits to obtain the next equation which is the equation of consumption growth rate such as:

$$\lambda = \frac{\dot{c}}{c} = \frac{\alpha(1-\tau)\left\{\alpha + (g/k)^{-\xi}\left[\beta\phi^{-\xi} + \gamma(1-\phi)^{-\xi}\right]\right\}^{-(1+\xi)/\xi} - \rho}{\sigma} \quad (6)$$

The growth rate of consumption, so called the steady state growth rate of consumption assume that along the steady state growth path, the tax rate $\tau(\tau = g/y)$ is constant. So from (1) and (2), we obtain:

$$g/k = \left\{\left[\tau^{\xi} - \beta\phi^{-\xi} - \gamma(1-\phi)^{-\xi}\right]/\alpha\right\}^{1/\xi} \quad (7)$$

From (7) to (6), we have:

$$\lambda = \frac{\alpha(1-\tau)\left\{\alpha\tau^{\xi}/\left[\tau^{\xi} - \beta\phi^{-\xi} - \gamma(1-\phi)^{-\xi}\right]\right\}^{-(1+\xi)/\xi} - \rho}{\sigma} \quad (8)$$

From (8), we obtain a relationship between λ and g_1 such as:

$$\frac{d\lambda}{d\phi}=\frac{\alpha(1-\tau)(1+\xi)\left[\alpha\tau^{\xi}\right]^{-(1+\xi)/\xi}\left[\beta\phi^{-(1+\xi)}-\gamma(1-\phi)^{-(1+\xi)}\right]}{\sigma\left[\tau^{\xi}-\beta\phi^{-\xi}-\gamma(1-\phi)^{-\xi}\right]^{-1/\xi}} \quad (9)$$

So, g_1 is productive if $d\lambda/d\phi \succ 0$. Assuming λ (from equation (6)) is positive, equation (9) will be positive if

$$(1+\xi)\left[\beta\phi^{-(1+\xi)}-\gamma(1-\phi)^{-(1+\xi)}\right]\succ 0 \quad (10)$$

Considering $\xi \geq -1$, so $d\lambda/d\phi \succ 0$ if $\frac{\phi}{1-\phi} \prec \left(\frac{\beta}{\gamma}\right)^{\theta}$ (11)

Where $\theta = 1/(1+\xi)$, the elasticity of substitution.

To understand the implication of this condition (equation 11), the Cobb-Douglas technology case is considered. In this case, $\xi = 0$ and $\theta = 1$, such as:

$$\frac{\phi}{1-\phi} \prec \frac{\beta}{\gamma} \quad (12)$$

In this condition, the relative share of public spending devoted to g_1 and g_2 is below their relative output elasticities (β and γ are the output elasticities of g_1 and g_2, respectively). So, the transfer of resources from g_2 (so called unproductive spending) to g_1 (so called productive spending) will raise the steady-state growth rate. This condition has to be followed by the case where the relative budget shares are below the relative output elasticities.

So from above, we can say that government expenditures influence the growth rate through the marginal production of capital. But this influence depends on the relative productivity of g_1 and g_2 and their relative budget shares θ and $(1-\theta)$. We can also say that the developed model shows the link between the share of government spending and the long-term growth.

To check this model empirically, we use GDP/k (gross domestic product per capita) as dependent variables and government spending as the main independent variables. As Devarajan et al. (1996), Gosh et Gregoriou (2008), and Chu et al. (2020), we divide government spending into two groups and let the data determine the nature of these groups. If one of these groups contributes to the growth and the second one no, we assume that the first one is productive and the second one nonproductive. The reason of this approach is to show, like Devarajan et al. (1996), Chu et al. (2020), that there are some components of government spending that are growth contributors. Besides, we extend their analysis by considering cross-dependence and endogeneity issues among variables, including

government spending on environment protection, corruption and political stability in the model, and examining the nonlinear relationship between the studied variables.

Clearly, suppose the results show that the sum of public expenditure on education, health, defense, general public services, housing, economic affairs contribute to growth, and spending on public order and safety, and recreation and social protection do not contribute to growth. In that case, we can say that the first one is productive, while the second one is nonproductive.

In addition to these variables, we add government spending on environmental protection and some control variables to the model. These control variables are investment (Gross fixed capital formation), inflation rate, political stability, control of corruption, tax revenue, non-tax revenue, budgetary deficit, or surplus, and crisis.

Investment is used to express the effect of physical capital accumulation as in the work of Devarajan et al. (1996); Gosh et Gregoriou (2008); Gupta et al. (2005); Gnangoin et al. (2019).

Christie (2012); Pushak et al. (2007) indicated the effect of inflation on economic growth in their studies. They stated that there is an adverse effect of inflation on growth rate when it is high. So, high inflation reduces the growth rate.

Political stability and corruption effects on growth are highlights by Shabbir and al. (2016). In their studies, these authors showed that political stability and corruption determine growth and influence growth determinants.

As stated by Kneller et al. (1999), Bleaney et al. (2001), Bose et al. (2007), Gemmell et al. (2016), Chu et al. (2020), we include components of the government budget revenue side to Devarajan et al. (1996) model. In effect, the inclusion of these variables (Tax revenue, non-tax revenue, budget surplus, or deficit) permits, as shown by these authors, to obtain a more robust coefficient in our estimations. These choices of government budget constraint variables are made considering that we are in a closed system in our study. In effect, in a closed system government expenditures must be financed by revenue (Revenue=Tax revenue + Non-tax revenue) and or budget surplus /deficit.

The last control variable (crisis) reflects the effect of the 2008 world financial crisis on economic growth in the studied countries.

To study the relationship between productive and nonproductive government spending and economic growth, we extend the previous model developed by Devarajan et al. (1996) and Chu et al. (2020) by adding in this model five variables: government spending on environmental protection, political stability, control of corruption and crisis. We obtain the two following models:

$$G_{it} = a_i + b_t + \alpha_1 G_{it-1} + \beta_1 \left(\frac{g_{pro,it}}{g_{pro,it} + g_{nonpro,it} + g_{env,it}} \right) + \beta_2 \left(\frac{g_{env,it}}{g_{pro,it} + g_{nonpro,it} + g_{env,it}} \right) + \gamma_1 \left(\frac{TR_{it}}{y_{it}} \right) + \gamma_2 \left(\frac{NTR_{it}}{y_{it}} \right) + \gamma_3 \left(\frac{Def_{it} / Sur_{it}}{y_{it}} \right) + \sum_{l=1}^{k} \sigma_l I_{ilt} + \mu_{it} \quad (13)$$

$$G_{it} = a_i + b_t + \alpha_1 G_{it-1} + \beta_3 \left(\frac{g_{nonpro,it}}{g_{pro,it} + g_{nonpro,it} + g_{env,it}} \right) + \beta_4 \left(\frac{g_{env,it}}{g_{pro,it} + g_{nonpro,it} + g_{env,it}} \right) + \gamma_4 \left(\frac{TR_{it}}{y_{it}} \right) + \gamma_5 \left(\frac{NTR_{it}}{y_{it}} \right) + \gamma_6 \left(\frac{Def_{it} / Sur_{it}}{y_{it}} \right) + \sum_{l=1}^{k} \sigma_l I_{ilt} + \mu_{it} \quad (14)$$

We express these dynamic models with respect to the work of Bleaney et al. (2001), Bose et al (2007) and, Gupta et al. (2005), Arsic et al. (2017), Van Eyden et al (2019). In effect, a lagged dependent variable is included among the regressors to capture the economic growth process dynamic nature.

The equations (13) and (14), analyzing the relationship between productive government expenditure and economic growth and nonproductive government expenditure and economic growth, respectively.

In these equations (13) and (14), *i* and *t* denote the cross-sectional and time-series dimensions, respectively, capturing the time-invariant unobserved country-specific fixed effects and the unobserved individual-invariant time effects.

G, corresponding to growth rate per capita;

G_{it-1}, is the lagged growth rate per capita;

$\frac{g_{pro}}{g_{pro} + g_{nonpro} + g_{env}}$, is productive expenditure as a proportion of total government expenditure (TGE);

$\frac{g_{nonpro}}{g_{pro} + g_{nonpro} + g_{env}}$, is nonproductive expenditure as a proportion of total government expenditure (TGE);

$\frac{g_{env}}{g_{pro} + g_{nonpro} + g_{env}}$, is government expenditure on environmental protection as a proportion of total government expenditure (TGE);

$g_{pro} + g_{nonpro} + g_{env}$, is total government expenditure (TGE);

$\frac{TR}{y}$, is tax revenue to GDP ratio;

$\frac{NTR}{y}$, is non-tax revenue to GDP ratio;

$\frac{Def / Sur}{y}$, is budget deficit or surplus to GDP ratio with $\frac{Def / Sur}{y} = \left[\left(\frac{TR}{y} + \frac{NTR}{y} \right) - \frac{g_{pro} + g_{nonpro} + g_{env}}{y} \right]$;

y, is GDP;

I_{ilt}, is vector of non-fiscal independent variables (inflation, investment, political stability, control of corruption, crisis).

3.2 Data

In this study, we use annual data of a panel of 35 countries (13 high-income countries, 22 low to middle-income countries) for 1993-2018 to analyze the link between public spending and economic growth. The studied countries are Australia; Croatia; Hungary; Iceland; Israel; Kuwait; Macao; Poland; Seychelles; Singapore; United Arab Emirates; United Kingdom; United States; Albania; Azerbaijan; Belarus; Bulgaria; China; Costa Rica; Egypt; El Salvador; Georgia; Kosovo; Kyrgyz Republic; Mauritius; Moldova; Mongolia; Romania; Russian Federation; Serbia; South Africa; Turkey; Ukraine; Uzbekistan; Afghanistan.

The classification of countries as high, middle, low-income is according to the World Bank classification. In effect, for the 2020 fiscal year, low-income countries are defined as countries with a gross national income per capita (GNI per capita), calculated using the World Atlas method, of 1025$ or less; middle-income countries are those with a GNI per capita between 1026$ and 12375$; high-income countries are countries with a GNI per capita of 12376$ or more. The gross national income (GNI) is calculated by adding gross domestic product to factor incomes from foreign residents, then subtracting income earned by non-residents.

Based on the work of Bleaney et al. (2001), Adam et Bevan (2005), Park (2006), Christie (2012), and Chu et al. (2020), productive government spending is considered as the sum of public spending in education, health, defense, housing, economic affairs, and general public services expenditures, while nonproductive expenditure consists of expenditure on public order and safety, recreation and social protection.

According to their availability for each country, data on each fiscal variable are collected from the International Monetary Fund Government Finance Statistics (IMF, 2019). These data sources give us a consolidated updated central government records, including sectorial decompositions of government expenditures and total revenues.

The remaining data are from the World Development Indicators (World Bank, 2019a) and the World Governance Indicators (World Bank, 2019b). All these data can be described as following (Table 1):

- Growth rate, which is annual per capita GDP in percentage, for country *i* during period *t*;
- Lagged growth rate, which is annual per capita GDP in percentage, for country *i* during period *t-1*.
- Productive spending, which is the sum of public spending on education, health, defense, housing, economic affairs and general public services expenditures. It is measured in percentage of total government expenditure;
- Nonproductive spending, which is the sum of expenditure on public services in order and safety, and recreation and social protection. It is measured in percentage of total government expenditure;

- Public spending on environmental protection, which includes spending for: waste management, waste water management, pollution abatement, protection of biodiversity and landscape, research and development environment protection, and environmental protection not elsewhere classified (n.e.c). It is measured in percentage of total government expenditure ;
- Public spending on general public services, which includes spending for: executive and legislative organs, financial and fiscal affairs, general services, basic research, external affairs, research and development general public services, general public services not elsewhere classified (n.e.c). It also includes foreign economic aid, public debt transactions and transfers of a general character between different levels of government. It is measured in percentage of total government expenditure;
- Public spending on defense, which includes spending for: military defense, civil defense, foreign military aid, research and development defense and defense not elsewhere classified (n.e.c). It is measured in percentage of total government expenditure;
- Public spending on public order and safety, which includes spending for: police services, fire protection services, law courts, prisons, research and development public order and safety, and public order and safety not elsewhere classified (n.e.c). It is measured in percentage of total government expenditure;
- Public spending on economic affairs, which includes spending for : general economic , commercial and labor affairs, agriculture, forestry, fishing and hunting, fuel and energy, mining, manufacturing and construction, transport, communication, others industries, research and development economic affairs and economic affairs not elsewhere classified (n.e.c). It is measured in percentage of total government expenditure;
- Public spending on housing and community amenities, which includes public spending for: housing development, community development, water supply, street lighting, research and development housing and community amenities, housing and community amenities not elsewhere classified (n.e.c). It is measured in percentage of total government expenditure;
- Public spending on health, which includes public spending for: medical products, appliances and equipment, outpatient services, hospital services, public health services, research and development health, and health not elsewhere classified. It is measured in percentage of total government expenditure;
- Public spending on recreation, culture and religion, which includes public spending for: recreational and sporting services, cultural services, broadcasting and publishing services, religious and other community services, research and development recreation, culture and religion, recreation, and culture and religion not elsewhere classified (n.e.c). It is measured in percentage of total government expenditure;
- Public spending on education, which includes public spending for: pre-primary and primary education, secondary education, post-secondary non-tertiary education, tertiary education, education not defined by level, subsidiary services to education, research and development education, and education not elsewhere classified (n.e.c). It is measured in percentage of total government expenditure;
- Public spending on social protection which includes public spending for: sickness and disability, old age, survivors, family and children, unemployment, housing, social exclusion not elsewhere classified , research

and development social protection, and social protection not elsewhere classified (n.e.c). It is measured in percentage of total government expenditure;

- Non tax revenue, which is the government revenue from sources other than taxes such as grants and other revenue. It is measured in percentage of GDP;
- Tax revenue, which is the government revenue collected from taxes on income, profit and capital gains, taxes on payroll and workforce, taxes on property, taxes on goods and services, taxes on international trade and transactions, social contributions, and other taxes. It is measured in percentage of GDP;
- Deficit or Surplus, which is the negative or positive difference between government revenue and spending during a set period. It is expressed in percentage of GDP;
- Inflation (i.e., GDP deflator) which is an increases in the general level of prices of goods and services. It is measured in percentage;
- Investment (i.e., gross fixed capital formation) which shows how much of the new value-added in the economy is invested rather than consumed. It is considered as private investment and expressed in percentage of GDP;
- Political stability and absence of violence or terrorism which measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. It is ranges from -2.5 (high instability) to 2.5 (strong stability);
- Control of corruption which reflects perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption. It is ranges from -2.5 (weak governance performance) to 2.5 (strong governance performance).
- Crisis which reflects the effects of the 2008 financial crisis during the studied period. It is a dummy variable.

Table 1 Variables description

Variables	Description	Unit
GDP/k	Gross domestic product per capita annual growth	percentage
DGDP/k	Lagged gross domestic product per capita annual growth	percentage
Prod	Public productive spending	percentage of TGE
Nonprod	Public nonproductive spending	percentage of TGE
General	Public spending on general public services	percentage of TGE
Defense	Public spending on defense	percentage of TGE
Order	Public spending on public order and safety	percentage of TGE
Affairs	Public spending on economic affairs	percentage of TGE
Env	Public spending on environmental protection	percentage of TGE
Housing	Public spending on housing and community amenities	percentage of TGE
Health	Public spending on health	percentage of TGE

Recreation	Public spending on recreation, culture and religion	percentage of TGE
Edu	Public spending on education	percentage of TGE
Social	Public spending on social protection	percentage of TGE
Nontax	Non tax revenue	percentage of GDP
Tax	Tax revenue	percentage of GDP
Def/Sur	Deficit or Surplus	percentage of GDP
Inf	Inflation	percentage
GFCF	Investment	percentage of GDP
Stab	Political stability	range
Corr	Control of Corruption	range
Crisis	2008 financial crisis	dummy

Before analyzing the relationship between our variables, we apply, as Devarajan et al. (1996), Gosh et Gregoriou (2008), Chu et al. (2020), five years moving average for all variables. In so doing, we attempt to eliminate business cycle effects and smooth out short-term fluctuations in the studied panel. We also plan to increase the number of time observations, minimize the reverse causality argument holding in the model, and account for endogeneity.

Given that the study makes use of a dynamic growth model specification, and to deal with different types of econometric issues, and ensure robust results, different estimators are applied to the dataset. There are the ordinary least square (OLS) fixed-effects, the pooled standard errors Driscoll-Kraay analysis, the feasible generalized least squares (FGLS), and the Arellano-Bond generalized method of moments (GMM) with orthogonal deviations. We analyze our data using these four estimators because, according to Ehigiamusoe et Lean (2018), using multiple estimators permits to have robust and reliable coefficients.

3.3. Estimation procedure

We start this estimation by studying the data through descriptive analysis, panel unit root tests, and diagnostic tests. Then, we analyze the relationship between the dependent and independent variables using OLS fixed effects, Driscoll-Kraay pooled OLS with standard errors, feasible generalized least squares (FGLS), and the difference GMM with orthogonal deviations.

3.3.1 Panel unit root tests

After data descriptive analysis, we perform three different types of unit root tests; so-called first generation unit root tests (See Appendix, Table A1 and A2) to check the variables stationnarity. These tests are, respectively, the Levin, Lin, and Chu or LLC test (Levin et al., 2002), the Im, Pesaran, et Shin (Im et al., 2003) or IPS test, and the ADF – Fisher developed by Maddala et Wu (1999), and Choi (2001).

The LLC test (Levin et al., 2002) is the most widely used panel unit root test. It is based on the Augmented-Dickey Fuller (ADF) test but in panel settings. The LLC test is specified as follow:

$$\Delta y_{it} = \alpha_i + \beta_i y_{it-1} + \sum_{j=1}^{p_i} p_i \Delta y_{it-j} + e_{it} \quad (15)$$

Where Δ is the first difference operator, y_{it} is the series of observations for country *i* for *t=1,...,T* periods. We test the null hypothesis of $\beta_i = \beta = 0$ for all *i* against the alternative of $H_1 = \beta = \beta_i \prec 0$, which presumes that all series are stationary. The LLC procedure proceeds from the assumption of homogeneity in all panel units; however, it has low power in the case of small samples because of serial correlation that cannot be removed with this test. β_i is identical across countries.

IPS test (Im et al., 2003) is an extension of the LLC test that relaxed the homogenous assumptions by allowing for heterogeneity in the autoregressive coefficients for all panel members (β varies across units under the alternative hypothesis). This test also removes serial correlation and in this way has the ability to test small samples (Wang et al., 2011).

The last test is the ADF-Fisher test developed by Maddala et Wu (1999), and Choi (2001). This test is a non-parametric and exacts test, which allows heterogeneity in panel units as much as possible and don't require panel balance.

3.3.2. The panel fixed effect approach and diagnostic tests

a. The panel fixed-effects approach

As the variables stationary at level, we estimate the model through OLS panel fixed-effects procedure. The OLS fixed-effects permits to address the presence of an unobserved country effect generally encountered in panel data. This model also permits to deal with heterogeneity in data. The fixed-effect model assumes that the relationships between variables are the same for all individuals.

By using fixed-effects approach, we assume that something within the individual may impact or bias dependent or independent variables and we need to control for this. The fixed-effect approach removes the effect of time-invariant characteristics so we can assess the net effect of the independent on the dependent variable. The model is then written as follows:

$$GDP/k_{it} = a_i + \delta_1 DGDP/k_{it} + \delta_2 \mathrm{Pr}od_{it} + \delta_3 Env_{it} + \delta_4 Controls_{it} + \varepsilon_{it} \quad (16)$$

$$GDP/k_{it} = a_i + \delta_5 DGDP/k_{it} + \delta_6 Nonprod_{it} + \delta_7 Env_{it} + \delta_8 Controls_{it} + \varepsilon_{it} \quad (17)$$

Where a_i, encompasses all observable effects and characterizes an estimated conditional average. For this fixed-effects approach, a_i is a consistent term specific to country *i;*

i=1,..., N, the number of panels; *t*=1,…, T; the number of period in panel *i*, and

GDP/k_{it}, is the dependent variable representing economic growth;

$\Pr od_{it}$, $Nonprod_{it}$, Env_{it} are the main explanatory variables representing productive public spending, nonproductive public spending and public spending on environmental protection, respectively;

$Controls_{it}$ denotes a group of control variables, which have an influence on dependent variable and vary over *t* and *i* such as $Controls_{it} = \left[gfcf_{it}, stab_{it}, \inf_{it}, tax_{it}, nontax_{it}, sur/def_{it}, crisis_{it} \right]$;

ε_{it}, is the error term. The variables of these different equations are presented in Table (4).

b. **Diagnostics test**

We consider the variance inflation factor (VIF) test to address the likely issue of multicollinearity among independent variables by removing the highly correlated variables from the regressions (See Appendix Tables A3, A4, A5 and A6). The VIF test shows how much an estimated coefficient's variance increases ("inflates") due to the problem of multicollinearity with other independent variables. Although the lower bound of the VIF is 1, there is no consensus about the upper bound beyond which multicollinearity arises. Hence, we assume that there is a multicollinearity problem when a VIF is greater than 10, following previous studies (Marquardt, 1970; Neter et al., 1989; Kennedy, 1992; Hair et al., 1995; Dormann et al., 2013; El-Bannany, 2017).

We also apply the Wooldridge test (2002), and the cross-sectional dependence test, following the methodology of Breusch-Pagan (1980), and Pesaran (2004) (Table 8).

The Wooldridge test, which is an autocorrelation test for panel data, follows the null hypothesis that there is no serial correlation among variables against the hypothesis that there is a serial correlation. The cross-dependence tests are respectively, the Breush-Pagan LM test and the Pesaran test.

The Lagrange multiplier statistics proposed by Breusch and Pagan (Breusch-Pagan LM), to test cross-sectional dependence is specified as follow:

$$CD_{BP} - \sum_{i-1}^{N-1} \sum_{j-i+1}^{N} \hat{\rho}_{ij}^{2} \qquad (18)$$

Where $\hat{\rho}_{ij}$ represents the sample estimate of the pair-wise correlation coefficient of the residuals from Ordinary Least Squares (OLS) estimations. The LM test is valid under the null hypothesis of no cross-sectional dependence for panels in which $T \to \infty$ with fixed N.

CD_{BP} is asymptotically distributed as chi-squared with $N(N-1)/2$ degrees of freedom. For large panels where T and N tend to infinity, Pesaran (2004) developed the scaled version of the LM test (CD_{LM}) as follows:

$$\sum_{i-1}^{N-1}\sum_{j-i+1}^{N}\left(T\hat{\rho}_{ij}^{2}-1\right) \square N(0,1) \qquad (19)$$

However, the scaled version of the LM test in Equation (19) is likely to exhibit substantial size distortions for N large and T small. Pesaran (2004) developed a more general cross-sectional dependence test that is valid for panel data where $T \to \infty$ and $N \to \infty$.

$$CD-\sqrt{\left(\frac{2T}{N(N-1)}\right)}\left(\sum_{i-1}^{N-1}\sum_{j-i+1}^{N}\hat{\rho}_{ij}\right) \square N(0,1) \qquad (20)$$

In so doing, Pesaran (2004) shows that the CD test is robust for heterogeneous dynamic models. This test null hypothesis assumes the independence of the cross-section unit. So, based on the results, we found a cross-sectional dependence between panel time series.

As these tests show the presence of autocorrelation (Wooldridge, 2002) and cross-sectional dependence among variables (Breusch-Pagan, 1980; Pesaran, 2004), we apply second-generation unit root tests to analyze stationarity between variables.

In effect, after confirming the presence of cross-dependence among variables, we apply a robust panel unit root estimation technique which takes account of cross dependence while checking variables stationarity. Pesaran (2007) suggested the adoption of Dickey-Fuller based panel unit root tests to account for cross-dependence and heterogeneity in the series. Additionally, the test proposed by Pesaran (2007) displays better statistical properties over conventional stationarity tests (First generation tests), which motivated our choice. The cross-sectionally augmented Dickey-Fuller (CADF) proposed by Pesaran (2007) is also considered as second generation unit root test. It can be expressed as follows:

$$y_{i,t} = (1-\delta_i)\mu_i + \delta_i y_{i,t-1} + v_{i,t} \qquad (21)$$

Where $v_{i,t} = \gamma_i f_t + e_{i,t}$, with f_t, the observed common factor, $e_{i,t}$ is the individual-specific error. To account for unit root hypotheses, equation (21) can be specified as:

$$\Delta y_{i,t} = \alpha_i + \beta_i y_{i,t-1} + \gamma_i f_t + e_{i,t} \quad (22)$$

$\alpha_i = (1-\delta_i)\mu_i$, $\beta_i = -(1-\delta_i)$, and $\Delta y_{i,t} = y_{i,t} - y_{i,t-1}$. The null hypothesis of unit root test is given by $H_0 : \beta_i = 0$, for all *i* against the alternative hypothesis $H_1 : \beta_i \prec 0$ for i=1, 2,….. N_1;

$\beta_i = 0$ for i= $N_1 + 1, N_1 + 2$ ……*N*. The following CADF regression is used in Pesaran (2007) to test the above hypothesis.

$$\Delta y_{i,t} = a_i + b_i y_{i,t-1} + D_0 \overline{y_{t-1}} + D_i \Delta \overline{y_t} + \varepsilon_{i,t} \quad (23)$$

where $\overline{y}$ is the proposed proxy of the unobservable common factor proposed by Pesaran (2007) to remove the cross-section dependence due to a common shock which affect all the units similarly. The Pesaran (2007) CADF unit root test has also good properties and can account for serial correlation.

In the next step, we applied the Driscoll and Kraay pooled OLS with standard errors and the feasible generalized least square approach (FGLS) that correct autocorrelation and cross-dependence between variables. We then apply the difference GMM with orthogonal deviations which takes account of potential endogeneity and bias among variables.

3.3.3 The Driscoll and Kraay approach and the feasible generalized least square (FGLS)

In the presence of cross-dependence and serial correlation, the most appropriate choice is the pooled OLS standard errors developed by Driscoll et Kraay (1998), the Panel Corrected Standard Errors (PCSE), and the Feasible Generalized Least Squares (FGLS) estimators. In effect, these estimators are robust to cross-sectional dependence, serial correlation, and heteroscedasticity of the residuals across panel. Besides, the pooled OLS standard errors Driscoll et Kraay (1998) use a nonparametric method to estimate the standard errors and is robust to heteroscedasticity and auto-correlated errors between panels.

The choice between the PCSE and the FGLS estimators depends on the relationship between the cross-sectional dimension (N) and the time-series dimension (T). The PCSE is employed in the case of N higher than T, while FGLS when T is higher than N for all groups of countries. As in our study case, T is higher than N, we estimate the model using the feasible generalized least squares (FGLS) from Parks (1967), and Kmenta (1986) and the robust standard errors pooled OLS regression proposed by Driscoll et Kraay (1998). Specifically, we adopted the xtgls program for FGLS and xtscc program developed by Hoechle (2007) when using STATA software. This Hoechle (2007) procedure is suitable for balanced and unbalanced panel data that allows cross-sectional dependence across countries. The FGLS estimator is used here to check the robustness of Driscoll-Kraay estimator results.

The following equations are estimated using pooled OLS standard errors Driscoll et Kraay (1998) estimation:

$$GDP/k_{it} = \delta_0 + \delta_1 DGDP/k_{it} + \delta_2 \Pr od_{it} + \delta_3 Env_{it} + \delta_4 Controls_{it} + \varepsilon_{it} \quad (24)$$

$$GDP/k_{it} = \delta_0 + \delta_5 DGDP/k_{it} + \delta_6 Nonprod_{it} + \delta_7 Env_{it} + \delta_8 Controls_{it} + \varepsilon_{it} \quad (25)$$

Where

i=1,..., N, the number of panels; t=1,…, T; the number of period in panel i, and GDP/k_{it}, is the dependent variable representing economic growth;

$\Pr od_{it}$, $Nonprod_{it}$, Env_{it} are the main explanatory variables representing productive public spending, nonproductive public spending and public spending on environmental protection, respectively;

$Controls_{it}$ denotes a group of control variables, which have an influence on dependent variable and vary over t and i such as $Controls_{it} = \left[gfcf_{it}, stab_{it}, \inf_{it}, tax_{it}, nontax_{it}, sur/def_{it}, crisis_{it} \right]$;

ε_{it}, is the error term. The variables of these different equations are presented in Table (4).

3.3.4 The generalized method of moments with orthogonal deviations.

In the study of the relationship between fiscal policy (government expenditure or tax rate) and economic growth, many authors (Barro, 1990; Devarajan et al., 1996) have used the OLS fixed-effects model. But, the GMM (generalized method of moments) single equation model can capture the endogeneity aspects of the model better, given the cross-country heterogeneity in the data (Gosh et Gregoriou, 2008). That is why we use this approach to confirm our analysis results. In effect, the OLS fixed-effects model and Instrumental variables are often applied to panel estimations. Even though these methods are extensively used in the panel literature, they fail to capture cross-country heterogeneity. In order to capture the cross-country heterogeneity in the data, avoid endogeneity issues, and eliminate dynamic panel bias, we use the difference GMM estimator with orthogonal deviations. The difference GMM with orthogonal deviations can be applied in the case of $T \succ N$ (see Anderson et Hsiao, 1981; Arellano et Bond, 1991; Van Eyden et al., 2019).

The difference GMM with orthogonal deviations used in this analysis is the generalized method of moments approach proposed by Anderson et Hsiao (1981) and implemented by Arellano et Bond (1991) in their estimation procedure. This procedure addresses the dynamic nature of economic growth, considers the potential bias of order 1/T, which can happen when using dynamic models, and takes account of endogeneity.

In effect, the instrumental variable estimation method proposed by Anderson et Hsiao (1981) in their work offers consistent but not necessarily efficient estimates because it does not make use of all available moments conditions and it does not take into account the differenced structure on the residual disturbance. Arellano et Bond (1991) fixed this problem through their GMM estimation procedure. In effect, they argue that additional instruments can be

obtained in a dynamic panel data model if one utilizes the orthogonality conditions that exist between lagged values of the dependent variable and the disturbance term. This transformation consists of first-differencing the model to eliminate the individual effect and use all the past information of the dependent variable as instrument. This is commonly referred to the difference GMM. Besides, as the model gives post-estimations tests results for autocorrelation and over-identification, it permits to confirm the efficiency of instruments and the absence of serial correlation, hence the robustness and accuracy of our results.

These post-estimations tests suggested by Arellano et Bond (1991), and Blundell et Bond (1998) are the Sargan (1958) / Hansen (1982) test for the over-identification restrictions to test the overall validity of instruments and the Arellano-Bond serial correlation test conducts to examine the hypothesis that the error term is not serially correlated.

The null hypothesis of the Sargan test is H_0: The instruments as a group are exogenous. So, the higher the p-value of the Sargan statistic, the better it is. In the case of robust estimation, The Hansen J statistic is reported instead of the Sargan test with the same null hypothesis.

The Arellano-Bond test for autocorrelation has a null hypothesis of no autocorrelation and is applied to the differenced residuals. The test for first order autocorrelation AR (1) process in first differences usually rejects the null hypothesis. However, the test for second order autocorrelation AR (2) in first differences is more important because it detects autocorrelation in levels.

Based on this approach, we estimate the following equations:

$$GDP/k_{it} = \alpha_{it} DGDP/k_{it} + \beta_{it} \Pr od_{it} + \sigma_{it} Env_{it} + \gamma_{it} X_{it} + \upsilon_i + \mu_t + \varepsilon_{it} \quad (26)$$

$$GDP/k_{it} = \alpha_{it} DGDP/k_{it} + \beta_{it} Nonprod_{it} + \sigma_{it} Env_{it} + \gamma_{it} X_{it} + v_i + \mu_t + \varepsilon_{it} \quad (27)$$

Where,

i indicates the country (i=1,…., N) and *t*, indicates the time period (t=1,…., T).

$\Pr od_{it}$, is productive spending; $Nonprod_{it}$, is nonproductive spending;

Env_{it} is public spending for environmental protection; X_{it}, is a vector of control variables hypothesized to affect output growth; $\alpha, \beta, \sigma, \gamma$ are parameters to be estimated; v_i are country-specific effects; μ_i, are period specific effects, and ε_{it}, the error term.

4. Results and discussion

In light of theoretical studies, this empirical study will allow us to contribute to the economic analysis on this issue by showing the effectiveness of some theories and highlights their limits. In this section, we will describe the data before moving to econometric analysis.

4.1 Variables descriptive statistics

The evolution of economic growth and productive and nonproductive public spending in the case of low, middle and high-income countries is presented in the next figures.

In figure 1, we see the evolution of productive spending and economic growth from 1993 to 2018 in high income countries. The X-axis represents years, while Y-axis represents productive spending and economic growth for each country. The graphs show that from 1993 to 2018, in the case of Australia, Singapore, United Kingdom, United States, Hungary, Kuwait, United Arab Emirates, productive public spending and economic growth have the same evolution. Globally, this same evolution appears for each country especially from 2010. The graphs also show that from 1993 to 2018, in the case of Singapore and United States, productive spending is higher than economic growth (measured by GDP/k).

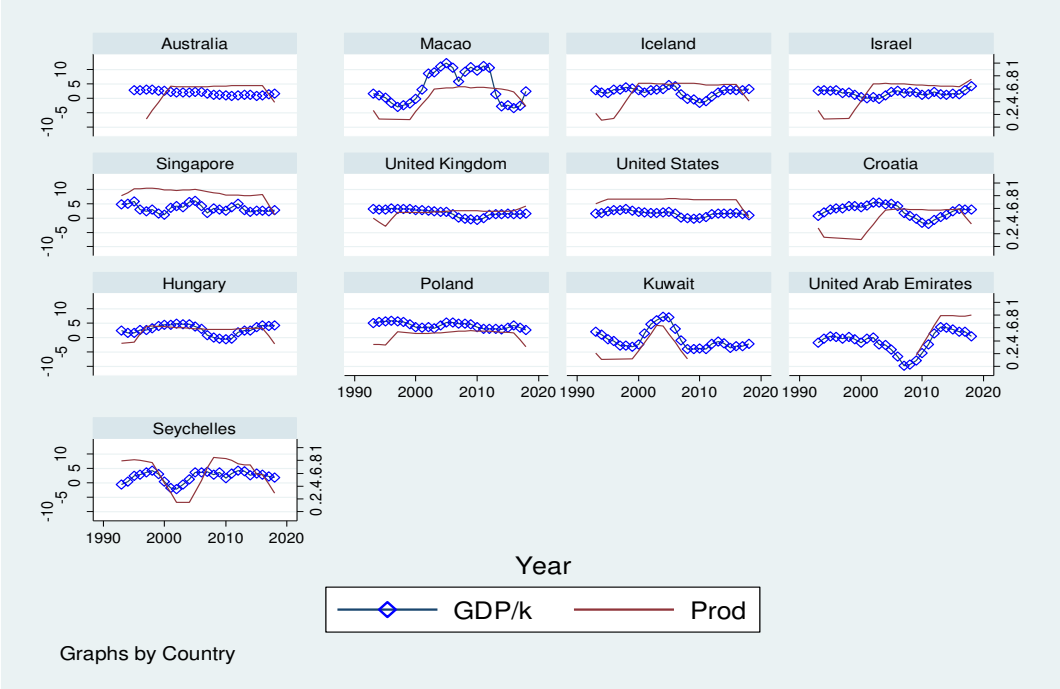

Figure 1: Productive spending and growth in high-income countries

In figure 2, we see the evolution of nonproductive spending and economic growth in high-income countries from 1993 to 2018. The X-axis represents years, while the Y-axis represents nonproductive public spending and economic growth for each country.

The graphs show that, in the case of Australia, Iceland, Singapore, United States, Kuwait, United Arab Emirates, the evolution of nonproductive and economic growth is globally the same. In the particular case of the United States, both graphs are mixed. So, we can assume the existence of a relationship between this spending and economic growth.

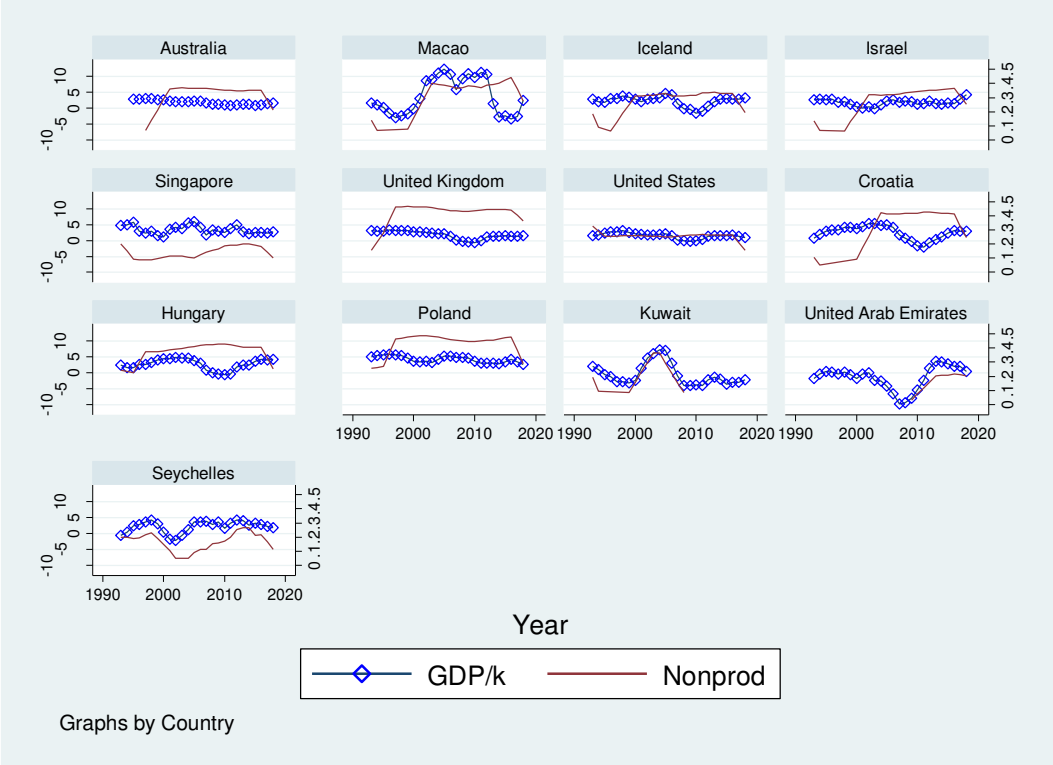

Figure 2: Nonproductive spending and growth in high-income countries

In figure 3, we see the evolution of productive spending and economic growth from 1993 to 2018 in low and middle income countries. The X-axis represents years, while the Y-axis represents productive spending and economic growth for each country. The graphs show that in the case of Bulgaria, Kosovo, Ukraine and Costa Rica, the trend of evolution of this spending and economic growth is the same.

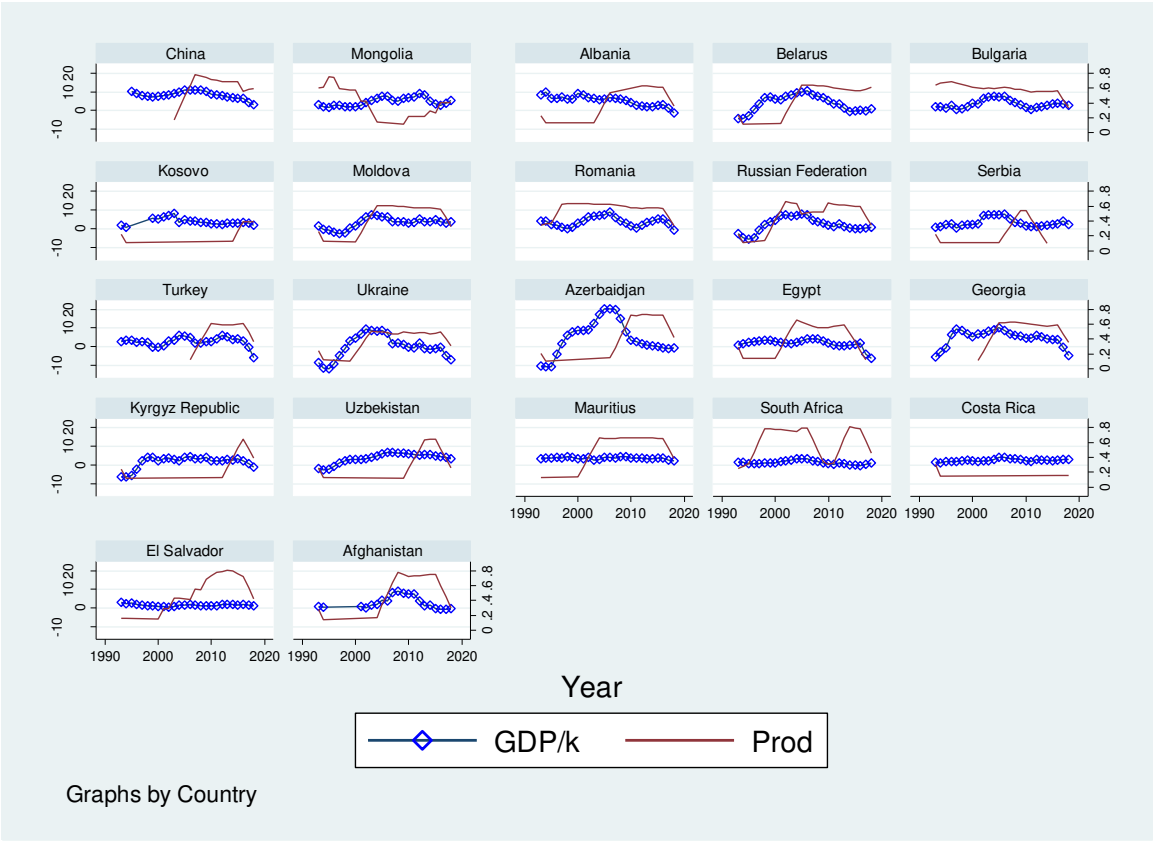

Figure 3: Productive spending and growth in low and middle-income countries

In figure 4, we see the evolution of nonproductive spending and economic growth from 1993 to 2018 in low and middle income countries. The X-axis represents years, while the Y-axis represents nonproductive spending and economic growth for each country. The graphs show that in the case of Bulgaria, Kosovo, Moldova, Mauritius, South Africa, Costa Rica, and Afghanistan, the trend of evolution of this spending and economic growth is the same.

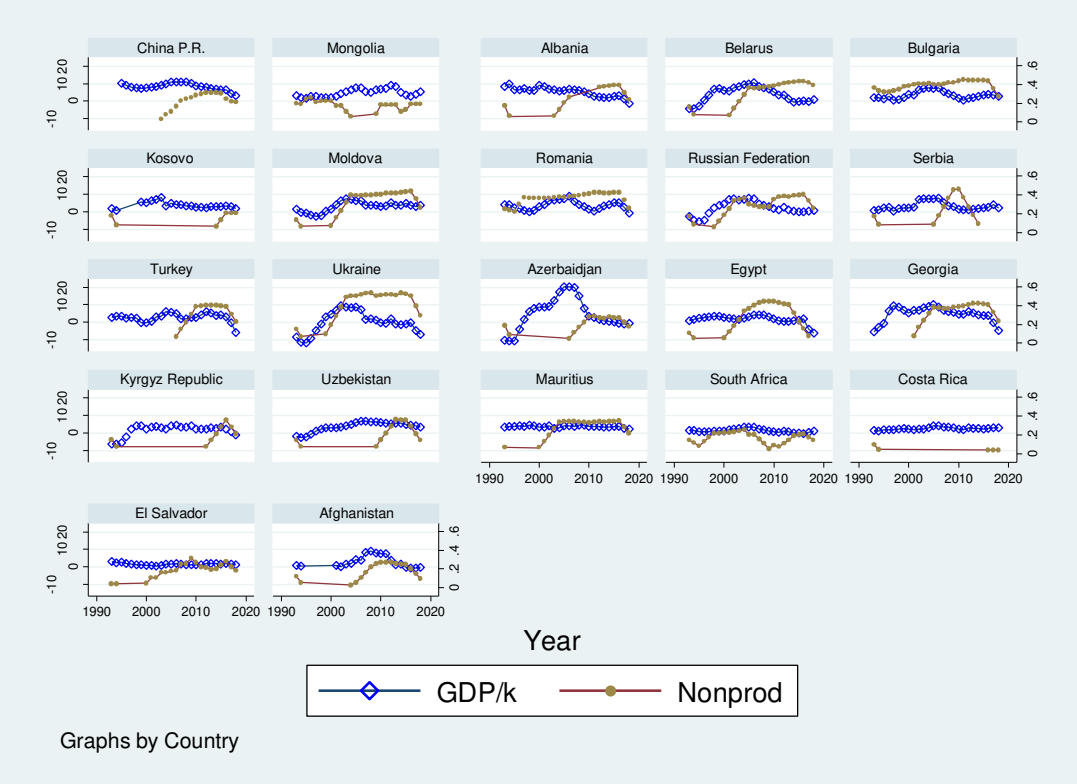

Figure 4: Nonproductive spending and growth in low and middle-income countries

The next table (table 2) shows the summary statistics of the data. It gives a detailed description of all the variables analyzed in this work. The investigated period is 25 years, and the number of countries is 35. We can see that high-income countries have a lower average growth rate than low and middle income countries, at 1.97% and 3.32%, respectively. Besides, we found that 23.83% of total expenditures of high-income countries are allocated to environment protection, while only 17.19 % is allocated to this spending. We also found that the percentage of total spending allocated to productive spending is higher in the case of low and middle income countries (63.29%) than those in the case of high-income countries (50.36%).

Table 2 Descriptive statistics

Variables	High income countries (323 observations)		Low and middle income countries (543 observations)	
	Mean	Standard deviation	Mean	Standard deviation
GDP/k	1.967	2.896	3.318	3.680
DGDP/k	1.969	2.900	3.309	3.739
Prod	50.363	26.1	63.291	48.648
Nonprod	25.807	15.1	19.524	16.460
Env	23.830	24.3	17.185	25.026
GFCF	19.548	8.080	22.196	7.420
Inf.	4.002	4.236	71.943	135.983
Stab	0.496	0.537	-0.283	0.648
Corr	0.824	0.669	-0.383	0.468
Def/Sur	1.761	38.498	-1.525	40.156
Tax	25.074	39.590	26.158	7.283
Nontax	13.022	12.217	22.074	1.158

4.2 Results and discussion for aggregated data.

4.2.1 Results and discussion for stationarity tests

The results of cross-dependence panel unit root tests for the studied variables are presented in the next tables (Tables 3 and 4). The results in Table 3 and 4 show that in high-income and low and middle-income countries, the variables are stationary at level.

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686 **Table 3 Panel unit root test for high-income countries**

	CADF	
	Level	
GDP/k	-1.739**	(0.041)
DGDP/k	-3.610***	(0.000)
Prod	-5.509***	(0.000)
Nonprod	-6.137***	(0.000)
Env	-1.544**	(0.026)
GFCF	-3.948***	(0.000)
Inf	-1.873**	(0.031)
Stab	-3.439***	(0.000)
Corr	-2.980***	(0.001)
Def/Sur	-2.122*	(0.051)
Tax	-1.934**	(0.027)
Nontax	-1.317*	(0.094)

687 P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

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Table 4 Panel unit root test for low and middle-income countries

	CADF	
	Level	
GDP/k	-3.530***	(0.000)
DGDP/k	-4.271***	(0.000)
Prod	-3.671***	(0.000)
Nonprod	-3.481***	(0.000)
Env	-5.860***	(0.000)
GFCF	-2.813***	(0.002)
Inf	-1.970**	(0.024)
Stab	-2.749***	(0.003)
Corr	-4.280***	(0.000)
Def/Sur	-2.600**	(0.027)
Tax	-2.849***	(0.002)
Nontax	-1.849**	(0.032)

P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

4.2.2 Results discussion for panel OLS fixed-effects, Driscoll-Kraay, FGLS analysis, and GMM with orthogonal deviations

The panel OLS fixed-effect has been applied because it permits to address the presence of an unobserved country effect generally encountered in panel data, and to deal with heterogeneity in data. So, it assumes that the relationship between the dependent variable and the independent variables are the same for all individuals. The OLS fixed effect estimator results are presented in Table 5.

719 **Table 5 Panel fixed effect results**

Dependent variable: per capita growth				
	High-income countries (323 observations)		**Low-to-middle income countries (543 observations)**	
	(1)	(2)	(1)	(2)
DGDP/k	0.805***	0.839***	0.837 ***	0.849***
	(0.000)	(0.000)	(0.000)	(0.000)
Prod	2.455***		2.191***	
	(0.000)		(0.000)	
Nonprod		2.244**		-3.892***
		(0.039)		(0.000)
Env	-0.850**	-0.340	0.983**	0.979**
	(0.037)	(0.400)	(0.083)	(0.080)
GFCF	-0.051***	-0.028	0.004	0.006
	(0.001)	(0.058)	(0.796)	(0.691)
Inf	0.004	-0.003	-0.001***	- 0.001***
	(0.828)	(0.899)	(0.000)	(0.000)
Stab	-0.098	-0.353	-0.024	0.044
	(0.777)	(0.314)	(0.920)	(0.853)
Corr	-0.328	-0.102	0.999***	0.964***
	(0.250)	(0.722)	(0.006)	(0.007)
Def/Sur	0.003	0.002	0.0005	0.001
	(0.431)	(0.605)	(0.754)	(0.549)
Tax	-0.002	-0.004	-0.058***	-0.049***
	(0.685)	(0.417)	(0.001)	(0.004)
Nontax	0.027**	0.029**	0.232**	0.201
	(0.051)	(0.035)	(0.011)	(0.027)
Crisis	-0.274	-0.254	-0.307	-0.286
	(0.452)	(0.4953)	(0.363)	(0.396)
No. of countries	13	13	22	22
F-test	61.091***	57.886***	88.946***	89.346***
	(0.000)	(0.000)	(0.000)	(0.000)
Hausman test	27.10***	33.08***	33.25***	25.31***
	(0.004)	(0.003)	(0.000)	(0.003)
Wooldridge test	144.114***	105.014***	37.380***	36.621***
	(0.000)	(0.000)	(0.000)	(0.000)
R-squared	0.824	0.815		

Adj. R-squared	0.810	0.802	0.847	0.848
Breusch-Pagan LM	269.959***	252.783***	0.838	0.839
	(0.000)	(0.000)	469.582***	451.862***
Pesaran CD test			(0.000)	(0.000)
	12.935***	12.074***		
	(0.000)	(0.000)	8.708***	8.357***
			(0.000)	(0.000)

P-values are in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

The post-estimations diagnostic tests showed that the fixed effects are preferred to OLS approach and random effect. In effect, this model is chose instead of random effect and OLS approach through Hausman (1978) test and F-test, respectively. The F-test was carried out to test the validity of the fixed effect estimation relative to the pooled OLS and the Hausman (1978) test was conducted to see the appropriateness of the fixed vs. random estimations approaches. So, the p-values of F-test ($p \prec 0.01$) and Hausman test ($p \prec 0.01$) lead us to choose fixed effect approach instead of OLS and random effects.

The robust standard errors pooled OLS Driscoll-Kraay (1998) has been applied because this estimator overcomes serial correlation and heterogeneity issues.

The Driscoll-Kraay estimator results (Table 6) show that:

- Productive spending in the percentage of total government expenditure has a positive effect on economic growth in low, middle, and high-income countries. Besides an increase of 1 point of productive spending in high-income countries contribute to economic growth by 1.294 point while this increase is by 1.451, in low and middle-income countries.
- Nonproductive government spending in the percentage of total government expenditure has a negative effect on economic growth in the case of low, middle and high-income countries. However, the effect of this spending in low and middle-income countries (-3.035) is different of those of high income countries (-1.201).

These results are consistent to those of Gemmel et al. (2016), Kimaro et al. (2017), Saez et al (2017), Chu et al. (2020) as we consider the government budget constraint in our model. In effect, as noted by Bose et al. (2007), Gemmel et al. (2016), and Chu et al. (2020), taking account of the global budget constraint in the model, permits to obtain more robust results.

We also found that:

- Public spending on environmental protection (Env) has a positive and significant effect on low-to-middle income countries economic growth. Hence, this spending can be considered as productive in the case of low and middle-income countries. This result is consistent with those of Barro et Sala-i-martin (1995).

This positive relationship may be due to the fact that this spending which is devoted to activities aimed at the prevention, reduction and elimination of pollution or any other degradation of the environment, in low or middle-income countries like China, India, Brazil, Russia, and Mexico, permits to improve the living conditions of population, thus improve human capital through safe air and water for instance. This improved human capital may have a better productivity which contributes to generate a green and sustainable growth.

In effect, the rapid evolution of low and middle-income economies has certain environmental consequences (outdoor air, and water pollution) which are damaging for population health. This situation has an impact on this population productivity, thus economic activity. The World Bank estimated that, in 2013, air pollution cost the world economy an average of $225 billion in lost labor income. Besides, the lack of infrastructures makes these countries particularly vulnerable to the effects of air pollution, water pollution, and soil degradation. Additionally, there are a lot of difficulties to access to health care and health services, in particular for women and children. So, this spending will overcome all these issues and contribute to growth.

- Inflation (Inf) has a negative and significant effect on low to middle-income countries economic growth.

In effect, as these countries economic structure (mainly dependent of the export of raw products such as oil, petroleum, coffee, cocoa… and the import of manufactured goods and services) and level of development, are particularly vulnerable to any change in the economy, the fall of the demand of raw product or the increase of the price of manufactured goods (which are paid in local currency) influences the local market by generating the rise of prices or the increase of taxes (in the case of the drop of raw product prices). This rising reduces local consumption, the level of investment, and the efficiency with which productive factors are used, which reduces economic growth. It effectively reduces the efficient allocation of resources by distorting the information content of prices, encouraging economic agents to spend more time and resources on gathering information and protecting themselves against the damages caused by price instability.

Another reason can be economic boom. In effect, high growth leads to more employment, which creates a fall of unemployment. This fall in unemployment puts upward pressure on wages which leads to higher inflation, hence influence negatively economic growth (the case of United Kingdom, during the late 1980s and the early 1990s when inflation increase to 8% as a result of high growth).

- Control of corruption (Corr) effect is positive and significant for our panel of countries.

This result is consistent with studies like Tanzi (1997) and Li et al. (2000) which found a positive link between a fall of corruption level and economic growth

In effect, corruption discourages private investment by generating social discontent which in turn may slow economic growth (Alesina, 1992). It also influences negatively growth by reducing the effectiveness of public investment, and reducing tax revenues through compromising the administration ability to collect taxes and fees. In the presence of corruption, the investments are smaller and/or ineffective, as entrepreneurs are aware that they will

have to bribe officials or give them a profit share for a successful implementation of a business. Additionally, when it takes the form of tax evasion or claiming improper tax exemptions, corruption may bring about loss of tax revenue, which reduces economic growth.

Besides, it generates a misallocation of public funds because a corrupt decision-maker will consider potential "corruption payments" as one of the decision criteria. It affects the quality of employment because the job does not go to the most suitable or qualified person but the one who is ready to pay for it or in any other way return the favor.

Indirectly, corruption may have a negative impact on economic growth through the allocation of talents, since prospective students are driven, due to the environment and the situation in the country to choose another major which would add value to the country.

Of particular relevance to developing countries is the possibility that corruption might reduce the effectiveness of aid flows through the diversion of funds, because the level of corruption discourages donors who scaled back their assistance, which reduce growth.

- The relationship between tax revenue (Tax) and economic growth is negative in the case of low-to-middle income countries while the effect of nontax revenue (Nontax) on growth is positive and significant.

This result show, as noted by Kneller et al. (1999), Lee et Gordon (2005), and Prichard (2016) that the effect of taxes on economic growth may be due to its nature.

Here, the negative effect of tax revenue on economic growth is consistent with the results of Ferede et Dahlby (2012). Taxes are the main and most important tool for collecting public revenues but their negative effect on growth is related to many factors. Taxes influence the decision to work and deploy capital because taxes affect the return to labor and capital. Indeed, the individual will to work or invested is affected by what the amount of his salary or what he will receive after taxes, if the latter is too low, it will discourage the incentive to work and/or the productivity, which will reduce growth . So, when taxes are too high, that discourages potential investors from realizing investments in the given countries, they incentives will be to invest in other countries with low taxes. Considering that the creation of new enterprises or foreign investment permit to create jobs and increase economic output, this low level of investment will impact negatively on economic growth.

The positive effect of nontax revenue on economic growth may be due to the fact that it is additional revenue, not collected like taxes, which can permit to increase public spending, and make it more efficient, thus contribute to economic growth.

- The relationship between financial crisis and economic growth is negative and significant in the case of high-income countries while its effect is not significant in the case of low and middle-income countries.

The financial crisis which started in the United States of America in 2008 had a big impact on world economy. But, as shown by the estimations results, its impact was different from one country to another.

This crisis generated a loss of income and jobs in many countries and its effects was severe in high-income countries maybe because it started in high-income countries, and financial sector (stock markets, financial activities) is more developed in high-income (North America, Europe) countries than in middle-income countries (Africa, Latin America, Asia), where this sector is still in development. It may also show that even there is interdependence among countries in the world this interdependence might not be strong enough to allow for a transmission of financial crisis effect from high-income to low and middle-income countries.

The negative effect of financial crisis on high-income countries economic growth can be explained by the loss of income (due to the crisis) in high-income countries.

In effect, the loss of income should affect the level of investment which may negatively impact economic growth. Also, this loss can generate a sharp fall in the demand for goods and services from low and middle-income countries to high income countries, which can create a decrease of production, so, an increase of unemployment and inequality in these countries which may negatively influence economic growth.

838 **Table 6 Panel Driscoll-Kraay results**

Dependent variable: per capita growth				
	High-income countries (323 observations)		**Low and middle income countries (543 observations)**	
	(1)	(2)	(1)	(2)
DGDP/k	0.853***	0.872***	0.886***	0.883***
	(0.000)	(0.000)	(0.000)	(0.000)
Prod	1.294***		1.452***	
	(0.003)		(0.000)	
Nonprod		-1.201*		-3.036***
		(0.094)		(0.000)
Env	0 .051	-0.057	0.636***	0.957***
	(0.796)	(0.865)	(0.001)	(0.000)
GFCF	-0.008	0.006	0.017	0.015
	(0.398)	(0.598)	(0.320)	(0.367)
Inf	-0.004	-0.011	-0.001**	-0.001**
	(0.875)	(0.601)	(0.027)	(0.027)
Stab	-0.021	-0.030	0.122	0.197
	(0.842)	(0.770)	(0.620)	(0.396)
Corr	0.276**	0.120**	0.360**	0.503**
	(0.014)	(0.021)	(0.024)	(0.014)
Def/Sur	0.002	0.002	0.0002	0.001
	(0.881)	(0.520)	(0.910)	(0.286)

Tax	0.004	0.002	-0.022*	-0.035***
	(0.373)	(0.703)	(0.066)	(0.002)
Nontax	0.0002	0.005	0.114**	0.154*
	(0.986)	(0.747)	(0.016)	(0.088)
Crisis	-0.381**	-0.351**	-0.338	-0.337
	(0.026)	(0.043)	(0.130)	(0.123)
No. of countries	13	13	22	22

P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

After analyzing the relationship between public spending and economic through Driscoll-Kraay estimator, we examine the link between these variables using the FGLS and GMM estimators. We apply FGLS estimator to check the robustness of Driscoll-Kraay results because this estimator is suitable to overcome cross-dependence and autocorrelation among variables for $T \succ N$. As the results of FGLS estimation (Table 7) confirm the Driscoll-Kraay estimator results, we apply the difference GMM with orthogonal deviations proposed by Anderson et Hsiao (1981) and Arellano et Bond (1991) in their estimation procedure.

858 **Table 7 Panel FGLS results**

Dependent variable: per capita growth				
	High-income countries (323 observations)		**Low and middle income countries (543 observations)**	
	(1)	(2)	(1)	(2)
DGDP/k	0.853***	0.872***	0.886***	0.883***
	(0.000)	(0.000)	(0.000)	(0.000)
Prod	1.294***		1.452***	
	(0.002)		(0.000)	
Nonprod		-1.201*		-3.036***
		(0.090)		(0.000)
Env	0.051	- 0.057	0.636*	0.957***
	(0.820)	(0.845)	(0.076)	(0.008)
GFCF	-0.008	0.006	0.017	0.015
	(0.470)	(0.573)	(0.840)	(0.123)
Inf	-0.004	-0.011	-0.001***	-0.001***
	(0.842)	(0.529)	(0.002)	(0.001)
Stab	-0.021	-0.030	0.122	0.197
	(0.886)	(0.842)	(0.362)	(0.138)
Corr	0.277**	0.119**	0.360**	0.503***
	(0.042)	(0.035)	(0.070)	(0.012)
Def/Sur	0.002	0.002	0.0001	0.001
	(0.990)	(0.512)	(0.925)	(0.453)
Tax	0.004	0.002	-0.022*	-0.035***
	(0.332)	(0.651)	(0.077)	(0.004)
Nontax	0.0002	0.005	0.114**	0.154**
	(0.983)	(0.653)	(0.013)	(0.041)
Crisis	-0.381*	-0.350**	-0.338	-0.337
	(0.086)	(0.030)	(0.316)	(0.312)
No. of countries	13	13	22	22

859 P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

860 The results of GMM estimator also show that spending considered as productive have positive and significant
861 impact on economic growth in the case of high and low-to-middle income countries, while spending considered as
862 nonproductive have a negative and significant impact on economic growth in the case of high-income and low-to-
863 middle income countries (Table 8).

The results also show that, public spending on environment protection (Env) has a positive and significant effect on low-to-middle income countries economic growth while this effect is not significant in the case of high income countries. Besides, we found that inflation (Inf) has a negative and significant effect on low to middle-income countries economic growth; while control of corruption (Corr) effect is positive and significant. The relationship between tax revenue (Tax) and economic growth is negative in the case of low-to-middle income countries while the effect of nontax revenue (Nontax) on growth is positive and significant.

Finally, the J Hansen test for over-identifications checking confirm the validity of the instruments used (higher p-value), and the Arellano-Bond AR (2) test for autocorrelation show that there is no serial correlation (higher p-value). So, the empirical results from these three estimators are robust and consistent.

In the next step of this work, we will re-estimate our variables by considering the individuals components of productive and nonproductive spending.

889 **Table 8 Panel GMM results**

Dependent variable: per capita growth				
	High-income countries (323 observations)		**Low and middle income countries (543 observations)**	
	(1)	**(2)**	**(1)**	**(2)**
DGDP/k	0.847***	0.869 ***	0.899***	0.899***
	(0.000)	(0.000)	(0.000)	(0.000)
Prod	1.413**		1.531**	
	(0.031)		(0.008)	
Nonprod		-1.241**		-3.539***
		(0.015)		(0.000)
Env	0.042	-0.058	0.589**	0.994***
	(0.845)	(0.726)	(0.017)	(0.010)
GFCF	-0.009	0.007	0.040	0.036
	(0.599)	(0.654)	(0.790)	(0.126)
Inf	-0.004	-0.012	-0.0004**	-0.0004
	(0.874)	(0.678)	(0.047)	(0.049)
Stab	-0.021	-0.027	0.061	0.142
	(0.786)	(0.740)	(0.722)	(0.367)
Corr	0.301**	0.128**	0.261***	0.426***
	(0.020)	(0.024)	(0.014)	(0.009)
Def/Sur	0.002	0.002	0.0003	0.002
	(0.967)	(0.931)	(0.653)	(0.571)
Tax	0.003	0.001	-0.020*	-0.036***
	(0.318)	(0.637)	(0.056)	(0.000)
Nontax	0.001	0.005	0.130**	0.182***
	(0.972)	(0.686)	(0.030)	(0.000)
Crisis	-0.389**	-0.355**	-0.378	-0.378
	(0.040)	(0.047)	(0.750)	(0.781)
No. of countries	13	13	22	22
AR(1)	-2.49*	-2.44*	-2.69**	-2.69**
	(0.013)	(0.015)	(0.007)	(0.007)
AR(2)	-1.63	-1.64	-1.45	-1.41
	(0.102)	(0.100)	(0.147)	(0.159)
Hansen J test	1.74	0.03	14.62	15.86
	(0.999)	(0.998)	(0.997)	(0.997)

890 P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

4.3 Results and discussion for disaggregated data.

In this part, we disaggregate productive and nonproductive spending in their different components to analyze their specific effects on economic growth.

4.3.1 Results and discussion for stationarity tests

In this step, we check the stationarity level of productive and nonproductive spending components before analysis. Productive spending is divided in public spending on education, public spending on health, public spending on defense, public spending on housing, public spending on economic affairs, public spending on general public services. Nonproductive spending is divided in public spending on public order and safety, public spending on recreation and public spending on social protection.

The results of panel unit root tests for disaggregated productive and nonproductive public spending in the case of low, middle, high-income countries are presented in the next tables (Table 9 and 10). The results in Table 9 and 10 show that in low, middle and high-income countries, the variables are stationary at level.

Table 9 Panel unit root tests for high-income countries.

		CADF	
		Level	
Prod	**Edu**	-1.994**	(0.037)
	Health	-1.778**	(0.038)
	Defence	-2.910***	(0.001)
	Housing	-2.809***	(0.002)
	Economic affairs	-2.867***	(0.002)
	General	-4.416***	(0.000)
Nonprod	**Order**	-3.801***	(0.000)
	Recreation	-1.746*	(0.058)
	Social	-5.241***	(0.000)

P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

Table 10 Panel unit root tests for low-to-middle-income countries.

		CADF	
		Level	
Prod	**Edu**	-2.906***	(0.002)
	Health	-3.151***	(0.001)
	Defence	-2.186**	(0.036)
	Housing	-4.168***	(0.000)
	Economic affairs	-7.109***	(0.000)
	General	-4.222***	(0.000)
Nonprod	**Order**	-1.721**	(0.043)
	Recreation	-4.859***	(0.000)
	Social	-3.908***	(0.000)

P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

4.3.2 Results discussion for panel Driscoll-Kraay, FGLS and GMM.

a. The linear approach

We estimate the linear relationship among variables using the pooled standard errors Driscoll-Kraay estimator (Table 11). These Driscoll-Kraay results (Table 11) are confirmed by the FGLS results (See Appendix Table A7) and the GMM results (See Appendix Table A8). In these tables, we show that:

- Public spending on education has a positive effect on economic growth in our panel of country case but its effect is not significant in the case of low and middle-income countries.

This result is consistent with those of Bose, Haque, et Osborn (2007), Gemmell, Kneller et Sanz (2015), Mallick, Pradeep et Pradhan (2016), Lupu et al. (2018). The effect of public spending on education is positive because, firstly, as an investment in human capital it may produce skilled workers with greater productivity which contributes to economic growth. Besides, a better-educated labor force increases the return on research and development and ensures that discoveries are more readily absorbed in the productive structure of the economy. So, more education equals more economic growth. This investment in human capital, also allows for greater innovation and specialization in higher value-added activities, which have a positive effect on growth. The significance of this effect in the specific case of high-income countries may be explained by the bidirectional relationship between these variables (Al-Yousif, 2008). Thus, if the idea about the fact that those countries with a greater level of development spend more on education, the positive and the bidirectional causality of the relationship between these variables may be one of the reasons for these countries' level of development.

This significance can also be due to the level of governance (institutional setting) in these different countries. In effect, according to the 2007 Organization for Economic Cooperation and Development report (OECD, 2007),

institutional settings influence the efficiency of education. Additionally, Wilson (2005) shows that this spending inefficiency in low and middle-income countries' is due to managerial ineptitudes or to other constraints outside authorities direct control (socio-economic background on education attainment).

- The effect of public spending on health on economic growth is negative and significant in high-income countries.

In the specific case of high-income countries, this negative effect might be due to the healthcare allocation (mainly private in these countries). In effect, in these countries, governments use private providers (clinics) for health services (including insurance). But, the charge of these services despite the State action is too heavy, so population (essentially poor people) cannot afford the cares they need, influencing their productivity, hence economic growth.

Besides, privatizing existing public services increases inequalities in the distribution of services, as private companies seek those with the highest incomes rather than the greatest needs. So it is hard for needy peoples to get the care they need which impacts their well-being. As spending on health impacts human and physical capital accumulation, this situation affects these people productivity, hence economic growth. The negative sign of this spending could also mean that the way of spending money is inefficient because this spending is used for unproductive projects, or the country's institutional capacity is weak, so it cannot check the efficiency of this spending.

- The effect of public spending on economic affairs on growth is negative and significant in low and middle-income countries.

This result is consistent with the conclusion of Lupu et al. (2018), showing the negative relationship between this spending and economic growth.

This negative relationship may be due to the non-efficiency of this spending. In effect, to contribute to economic growth, this spending has to be efficient but this efficiency is affected by factors such as the density of networks, capital costs, public objectives, infrastructure maintenance, and quality of infrastructures. In effect, if these infrastructures' quality is bad, it can increase the level of spending for its maintenance; hence generating more loss than benefits, and reducing economic growth. This negative relationship may also be due to the negative return of this investment, the loss of efficiency gains, productivity and innovation. In effect, due to competition with private sector, and the bad quality of their services, some sectors such as communication, mobile, internet are not efficient, as private services are preferred to public.

Additionally, the structural adjustment policies imposed by the IMF in these countries (African, Latin American, and East Asian countries) led to the fall of these investments (road, water, sanitation, and housing) which became less efficient, which is led to a fall in economic growth.

- The effect of public spending on general public services on economic growth is positive and significant in the case of our panel of countries.

The positive effect of this spending may be due to the fact that this spending supports employment through direct employment of public services workers, indirect employment of workers by contractors, extra jobs from the spending of the wages of public workers and of recipients of social security benefits (multiplier effect).

Besides, as this spending about executive and legislative organs, and financial and fiscal affairs, it contributes to the well-functioning of administration (through the improvement of equality in the employment sector), which become efficient and productive. It facilitates the relationship between government organs, hence improve regulatory quality. By paying attention to external affairs, and foreign economic aid, it also may contribute to the well-functioning of international trade and transactions between countries (loans, grants, aid);

- The effect of public spending on public order and safety on economic growth is positive in high-income countries while it is negative in low and middle-income countries.

The positive sign in the case of high-income countries and the negative sign for low and middle-income countries may be due to the amount of this spending in these different economies. In effect, the different results (See Appendix Table A9) show that the level of public spending on order and safety on high-income countries is lower than those on low and middle income countries. Also, as noted by Devarajan et al. (1996), public spending, if applied excessively can be unproductive.

The positive effect of public spending on public order and safety can be explained by the fact that this spending contributes to a well-functioning legal system, through institution of enforcing law, order and public safety, which is a condition for a good economic environment, hence a positive growth. Besides, as this spending is mainly a responsibility of governments, it is a public instrument to contribute to growth by increasing the marginal productivity of public and private supplied production factors, and also by contributing to better use of existing capital and labor assets.

- The effect of public spending on social protection on economic growth is negative and significant in the case of low and middle-income countries.

This result is consistent with those of Adam et Bevan (2005), and Lupu et al. (2018). This negative relationship may be due to the fact that this spending generates disincentives to work for potential recipients and /or stimulate socially unproductive rent-seeking. In effect, one example is unemployment benefits which can negatively influence people incentive to work, hence reducing productivity and growth.

Besides, by inducing early retirement, this spending reduces economic productivity, hence growth. In effect, considering this spending, people choose an earlier retirement age, which means they leave the labor force when the extra income they could produce is greater than the value they place on the extra leisure. That leaves society with less output because individuals face a distorted trade-off between labor and leisure.

996 **Table 11 Panel Driscoll-Kraay results**

Dependent variable: per capita growth				
	High-income countries (323 observations)		**Low-to-middle income countries (543 observations)**	
	(1)	**(2)**	**(1)**	**(2)**
DGDP/k	0.859***	0.848***	0.886***	0.879***
	(0.000)	(0.000)	(0.000)	(0.000)
Edu	0.301**		-0.090	
	(0.010)		(0.341)	
Health	-0.145**		-0.136	
	(0.034)		(0.140)	
Defence	-0.134		0.020	
	(0.719)		(0.585)	
Housing	0.170		0.126	
	(0.125)		(0.218)	
Affairs	-0.111		-0.113**	
	(0.207)		(0.025)	
General	0.021*		0.027**	
	(0.067)		(0.041)	
Order		0.429**		-0.057*
		(0.034)		(0.023)
Recreation		0.226		0.112
		(0.115)		(0.617)
Social		-0.034		-0.099***
		(0.218)		(0.002)
Env	0.036	-0.242	0.962***	0.936***
	(0.850)	(0.326)	(0.000)	(0.000)
GFCF	0.055	0.005	0.018	0.012
	(0.725)	(0.651)	(0.290)	(0.474)
Inf	-0.025	-0.009	-0.0004**	-0.001***
	(0.325)	(0.728)	(0.028)	(0.027)
Stab	-0.001	-0.167	0.223	0.207
	(0.996)	(0.531)	(0.391)	(0.379)
Corr	0.189**	0.121*	0.623*	0.625*
	(0.044)	(0.058)	(0.058)	(0.070)
Def/Sur	0.002	0.001	0.0005	0.002
	(0.211)	(0.570)	(0.732)	(0.137)

Tax	0.004	0.003	-0.022*	-0.034***
	(0.295)	(0.324)	(0.051)	(0.005)
Nontax	-0.004	-0.003	0.085*	0.135*
	(0.751)	(0.752)	(0.027)	(0.013)
Crisis	-0.305***	-0.387**	-0.306	-0.294
	(0.010)	(0.033)	(0.140)	(0.170)
No. of countries	13	13	22	22

P-value is in parenthesis *, **, *** denote the statistical significance at 10%, 5%, 1% level.

b. The nonlinear approach

To examine the nonlinear relationship between public spending and economic growth, we estimate our econometrical models following the concept of the Armey (1995) curve. According to this author, the effect of government expenditure on economic growth depends of the level of this spending. For him, the size of the government and economic growth can be modeled as a quadratic function (inverted U-shaped), which assumes a role for both the linear term and the squared term of government expenditure in the economic growth process. The upward-sloping portion of the curve demonstrates the productive effect of small government, while the downward-sloping portion of the curve exhibits those unproductive consequences of large government. The highest point illustrates the point where the marginal benefits from increased government spending reach zero.

The approach used in this study relates the significant public spending to economic growth. We add in the econometrical model the square of the significant public spending. The inclusion of this variable contributes to empirically verify the phenomenon of Armey curve within this framework.

$$y_t - y_{t-1} = \beta_0 + \beta_1 g_t - \beta_2 g_t^2 + ... + \varepsilon_t \quad (28)$$

The positive coefficient of the linear g term is related to the constructive effects of government spending on output, and the expecting negative effects of increased government size. This regression equation includes both the linear and the squared term of public spending *g* in the estimated equation, and therefore it is a quadratic function or, in other words, a second degree polynomial function. Applying the linear and quadratic function of public spending, we assume that the relationship between government spending and growth is uncomplicated and the curve depicting this relationship has no more than one maximum.

The graphical solution of the optimal amount of government spending is the peak of the quadratic curve. Alternatively, the mechanism specified below can be used to calculate the optimal level of government spending using partial differentiation.

$$y_t - y_{t-1} = \beta_0 + \beta_1 g_t - \beta_2 g_t^2 \quad (29)$$

$$\frac{\partial(y_t - y_{t-1})}{\partial(g_t)} = \beta_1 - 2(\beta_2) g_t \quad (30)$$

$$0 = \beta_1 - 2(\beta_2) g_t \quad (31)$$

$$g_t^* = \frac{\beta_1}{2\beta_2} \quad (32)$$

As the results show a positive relationship between public spending on education and economic growth in high-income countries, a positive relationship between public spending on general public services and economic growth in high-income countries and low and middle-income countries; a negative relationship between public spending on health and economic growth in high-income countries, a negative relationship between public spending on economic affairs and economic growth in low and middle-income countries, and a negative relationship between public spending on social protection and economic growth in low and middle-income countries, we attempts in this part to check the existence of linear or nonlinear relationship between these variables and green economic growth.

The results in Table 12 showed a nonlinear and significant relationship between public spending on education, and public spending on order and safety and economic growth in the case of high-income countries. The results also show a nonlinear relationship between public spending on economic affairs and economic growth in the case of low and middle income countries.

1046 **Table 12 Driscoll-Kraay results for public spending on education, order, and affairs**

1047 **Dependent variable: GDP/k**

1048

Dependent variable: per capita growth				
	High-income countries (323 observations)		**Low and middle income countries (543 observations)**	
	(1)	(2)	(1)	(2)
DGDP/k	0.831***	0.841***	0.888***	0.879***
	(0.000)	(0.000)	(0.000)	(0.000)
Edu	0.718**		-0.069	
	(0.013)		(0.127)	
EduSq	-0.049**			
	(0.030)			
Health	-0.181**		-0.102	
	(0.024)		(0.227)	
HealthSq				
Defence	-0.179**		0.014	
	(0.025)		(0.655)	
Housing	0.043		0.168	
	(0.711)		(0.137)	
Affairs	-0.088		-0.251**	
	(0.227)		(0.026)	
AffairSq			0.011**	
			(0.012)	
General	0.013		0.033	
	(0.660)		(0.341)	
Order		0.949**		-0.061
		(0.025)		(0.535)
OrderSq		-0.171**		0.0003
		(0.019)		(0.961)
Recreation		0.202		0.115
		(0.184)		(0.607)
Social		-0.045		-0.099
		(0.114)		(0.003)
Env	-0.105	-0.160	1.061***	0.940

	(0.604)	(0.572)	(0.000)	(0.001)
GFCF	0.002	0.001	0.019	0.012
	(0.885)	(0.896)	(0.268)	(0.473)
Inf	-0.028	-0.010	-0.001	-0.001
	(0.232)	(0.684)	(0.284)	(0.271)
Stab	-0.183	-0.148	0.202	0.206
	(0.319)	(0.088)	(0.439)	(0.386)
Corr	-0.099	-0.185	-0.603*	-0.624*
	(0.641)	(0.076)	(0.065)	(0.076)
Def/Sur	0.003	0.001	0.001	0.002
	(0.141)	(0.516)	(0.752)	(0.136)
Tax	0.005	0.003	-0.022	-0.034***
	(0.146)	(0.356)	(0.051)	(0.004)
Nontax	-0.008	-0.001	0.077	0.134
	(0.427)	(0.891)	(0.335)	(0.130)
Crisis	-0.267	-0.385	-0.337	-0.293
	(0.137)	(0.032)	(0.095)	(0.189)
No. of countries	13	13	22	22

P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

In Table 13, the results show the existence of a nonlinear and significant relationship between public spending on health and economic growth in the case of high-income countries. There is also a nonlinear and significant relationship between public spending on general affairs and economic growth in the case of low and middle-income countries. To end, the results show the existence of a nonlinear and significant relationship between public spending on social protection and economic growth in the case of low and middle-income countries.

1062 **Table 13 Driscoll-Kraay results for public spending on health, general and social**

1063 **Dependent variable: GDP/k**

1064

Dependent variable: per capita growth			
	High-income countries (323 observations)	**Low and middle income countries (543 observations)**	
	(1)	(1)	(2)
DGDP/k	0.853***	0.885***	0.881***
	(0.000)	(0.000)	(0.000)
Edu	0.272**	-0.083**	
	(0.016)	(0.048)	
Health	-0.068*	-0.108	
	(0.058)	(0.252)	
HealthSq	0.022*		
	(0.053)		
Defence	-0.111*	0.022	
	(0.055)	(0.548)	
Housing	0.158	0.124	
	(0.150)	(0.220)	
Affairs	-0.118	-0.106**	
	(0.176)	(0.030)	
General	0.015	0.042**	
	(0.593)	(0.050)	
GeneralSq		-0.005*	
		(0.090)	
Order			-0.053
			(0.264)
Recreation			0.343
			(0.249)
Social			-0.205**
			(0.030)
SocialSq			0.006**
			(0.017)
Env	-0.131	0.975***	1.047***
	(0.492)	(0.000)	(0.000)
GFCF	0.002	0.018	0.014

	(0.866)	(0.291)	(0.394)
Inf	-0.023	-0.001	-0.001
	(0.340)	(0.277)	(0.264)
Stab	0.015	0.222	0.221
	(0.930)	(0.398)	(0.380)
Corr	-.150	-0.614	-0.640
	(0.501)	(0.061)	(0.069)
Def/Sur	0.002	0.001	0.001
	(0.167)	(0.642)	(0.649)
Tax	0.004	-0.026**	-0.035***
	(0.249)	(0.016)	(0.004)
Nontax	-0.004	0.109	0.141
	(0.728)	(0.183)	(0.119)
Crisis	-0.286	-0.295	-0.324
	(0.129)	(0.163)	(0.123)
No. of countries	13	22	22

P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

In Table 14, the results show the existence of a nonlinear and significant relationship between public spending on general affairs and economic growth in the case of high-income countries.

1078 **Table 14 Driscoll-Kraay results for public spending on general**

1079 **Dependent variable: GDP/k**

Dependent variable: per capita growth				
	High-income countries (323 observations)		**Low and middle income countries (543 observations)**	
	(1)	(2)	(1)	(2)
DGDP/k	0.857		0.887***	
	(0.000)		(0.000)	
Edu	0.306		-0.064	
	(0.008)		(0.106)	
Health	-0.180		-0.121	
	(0.010)		(0.178)	
Defence	-0.128		0.019	
	(0.044)		(0.593)	
Housing	0.144		0.184	
	(0.207)		(0.154)	
Affairs	-0.111		-0.104**	
	(0.207)		(0.049)	
General	0.104**		0.019	
	(0.039)		(0.506)	
GeneralSq	-0.004**			
	(0.042)			
Order				
OrderSq				
Recreation				
Social				
Env	-0.127		0.789	
	(0.618)		(0.619)	
EnvSq			-1.878	
			(0.261)	
GFCF	0.006		0.019	
	(0.680)		(0.271)	

Inf	-0.032	-0.001
	(0.298)	(0.285)
Stab	-0.056	0.150
	(0.740)	(0.495)
Corr	-0.141	-0.502*
	(0.555)	(0.080)
Def/Sur	0.002	0.001
	(0.203)	(0.617)
Tax	0.004	-0.021*
	(0.253)	(0.070)
Nontax	-0.004	0.079
	(0.746)	(0.311)
Crisis	-0.291	-0.308
	(0.120)	(0.134)
No. of countries	13	22

P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

Based on equation (32), the maximal amount of public spending is as following (Table 15):

Table 15 Maximum spending

Variables		Maxima for High-income countries	Maxima for Low and middle income countries
Productive	Education	7.327	
	Health	1.545	
	General	13	4.2
	Affairs		11.409
Nonproductive	Order	2.775	
	Social		17.083

The results in Table 15 suggest that in the case of high-income countries:

- The curve peaks when public spending on education is approximately equal to 7.327% of total government expenditure; and when public spending on health is approximately equal to 1.545% of total government expenditure;

- The curve also peaks when public spending on general public services is approximately equal to 13% of total government expenditure; and when public spending on order and safety is approximately equal to 2.775 of total government expenditure.

The results in Table 15 also suggest that in the case of low and middle-income countries:

- The curve peaks when public spending on general public services is approximately equal to 4.2% of total government expenditure; when public spending on economic affairs is approximately equal to 11.409 % of total government expenditure; and when public spending on social protection is approximately equal to 17.083% of total government expenditure.

The results of the nonlinear relationship approach show that government policymakers have to pay attention to the level of public expenditure when they implement their policies, because after a certain level the effect of this spending on economic growth can be negative.

This nonlinear relationship suggests that the amount of public spending can/cannot exceed a certain level; otherwise this spending will contribute/reduce green economic growth.

This study considered the linear and nonlinear relationship instead of the other studies that only pay attention to the linear relationship.

5. Conclusion, Policy implications and future work

5.1 Conclusion

Public spending as an instrument of public policy is essential for the management of economic growth. In effect, considering that it is one of the main tools for government action, the analysis of its nature and contribution is important. In so doing, we attempted in our analysis to shed light on the relationship between public spending and economic growth by using an endogenous growth model developed by Devarajan et al. (1996).

To reach our objective, we use four estimation methods: the fixed-effect approach, the Driscoll and Kraay pooled OLS standards errors, the feasible generalized least squares and the difference generalized method of moments with orthogonal deviations. We used these different approaches to contribute to the empirical analysis of this relationship by taking account of cross-dependence among variables and endogeneity.

Our main findings showed that there is productive and nonproductive public spending. Productive spending has a positive effect on economic growth while nonproductive spending has a negative effect on economic growth. This result is consistent with those of Bleaney et al. (2001) and Chu et al. (2020). We also found that 2008 financial crisis has a negative effect on economic growth in high-income countries, while its effect is not significant in the case of low and middle-income countries.

Besides, after dividing productive and nonproductive spending into their components, we found that these components affect growth differently, according to the level of income and the level of spending. In other words, there is a linear and nonlinear relationship between disaggregated public spending and economic growth while considering low, middle and high-income countries.

So, in the case of high-income countries, public spending on education, public spending on general public services and public spending on public order and safety have a positive effect on economic growth, while public spending on health, and public spending on social protection have a negative effect on economic growth. In the case of low and middle-income countries, public spending on general public services has a positive effect on economic growth, while public spending on economic affairs has a negative effect on economic growth.

But, considering the existence of a nonlinear relationship between these spending and economic growth, these countries policymakers have to pay attention to the amount of the spending they implement while setting their policies.

Our analysis results also show that public spending on environmental protection has a positive and significant effect on low and middle-income countries' economic growth. Also, the inflation rate has a negative relationship with economic growth in low and middle-income countries while, control of corruption has a positive effect on growth in our panel of countries' case. Finally, the effect of tax and nontax is significant in the case of low and middle-income countries. But, while the effect of tax on economic growth is negative, the effect of nontax is positive.

5.2 Policy implications

Following authors like Barro (1990) and Devarajan et al. (1996), this study highlights the existence of a relationship between public spending and economic growth. Knowing the importance and the sensitivity of growth issues at the world level, this approach examines the effect of the different components of public spending on growth. We globally show that the effect, either positive or negative, of public spending on economic growth depends on the nature of the spending, on the level of the spending, and on the country level of development. Several policy suggestions can be given based on the results:

In high-income countries, public authorities have to pay attention to the level of public spending on health and social protection because under a certain level, these spending negatively impact economic growth. They also have to improve public spending on education, public spending on general public services, and public spending in order and safety, while being careful to the amount of this spending they use in the economy.

In performing these different policies, high-income economies also have to pay attention to corruption. In effect, an increase in the control of corruption in these countries leads to an increase of economic growth.

In low and middle-income countries, the governments have to implement policies to improve spending on general public services, while considering the amount of this spending they use. These governments' policy makers have also to pay attention to their spending on economic affairs, public order and safety, and social protection. These

countries also have to increase public spending on environmental protection and the control of corruption, manage the level of inflation and implement policies to reduce tax and improve nontax.

To set up efficiently these different policies, public authorities have to implement strong and high-quality institutions through the increase of the law force, the respect of the property rights, a better organization of public activities, a good allocation of public and private resources, a good interaction between government, public agents and firms, the implementation of rules and stability necessary for firms' investment and business planning.

High quality of institutions also means fighting against corruption by implementing policies to reduce the level of poverty, increase public employees' wages, and speed up the bureaucratic process. In effect, a high poverty level, low wages in the public sector and the slowness of bureaucratic process can easily drive bribery. Additionally, in the specific case of low and middle-income countries, governments might reduce their intervention in economic activity through policies aiming at liberalization, stabilization, deregulation and privatization. In effect, high levels of State intervention (protectionism, state-owned enterprises, price controls, exchange controls, import licenses) can create opportunities for bribery.

Decision-makers also have to consider spending which contributes to the growth and increases investment in these different sectors. As education and health are the main determinants of human capital productivity, public authorities have to orientate redistributive programs towards health and education, to improve the quality of the labor force. Besides, decision-makers have to examine health spending carefully and develop policies to improve public healthcare (to reduce the role of the private sector), nutrition, better sanitation, innovations in medical technologies, and public health infrastructure.

About the environment sector, the development of environmental-friendly policies such as the implementation of energy (from hydroelectric barrage), renewable energy (wind turbines, solar photovoltaic facilities) in the region specialized on the use of charcoal or atomic energy at the domestic and industrial level, will also contribute to growth via green energy.

Concerning the taxation effect on growth, a solution to manage its negative effect on growth is to well-designed tax policies. For example, reducing marginal tax rates on wages and salaries can induce people to work more, lower marginal tax rates on the returns to asset (such as interest, dividends and capital gains) can encourage saving, reducing marginal tax rates on business income can cause some companies to invest domestically rather than abroad, tax breaks for research can encourage the creation of new ideas that spill over to help the broader economy. Countries can also pay attention to tax on consumption which may contribute to growth, considering that this tax minimizes taxation distorting effects on the growth factors such as labor, capital, and technological progress. To end, as public spending is influenced by the level of income, governments have also to implement policies to improve their countries' level of income.

So, this paper is an important contribution to policy decision making because, by analyzing this relationship, it permits, firstly, to maintain and manage national economic conditions; secondly, to ensure through the necessary fiscal reforms or instruments that the system performs its redistributive function effectively.

5.3 Future research

The current research has several avenues to extend. One possible extension would be to analyze this relationship by region, to take into account regional characteristics, affecting public spending composition and other determinants of growth. Another one would be to include variables such as the level of pollution and consider the influence of this variable on public spending.

Appendix

Table A1: High income countries panel unit root tests.

	LLC		IPS		ADF-Fisher	
	Level		**Level**		**Level**	
GDP/k	-2.929***	(0.002)	-3.120***	(0.001)	48.540***	(0.005)
DGDP/k	-2.828***	(0.002)	-2.898***	(0.002)	46.067***	(0.009)
Prod	-3.919***	(0.000)	-2.570***	(0.005)	56.101***	(0.001)
Nonprod	-4.217***	(0.000)	-3.603***	(0.000)	58.351***	(0.000)
Env	-4.038***	(0.000)	-3.645***	(0.000)	59.168***	(0.000)
GFCF	-5.746***	(0.000)	-5.273***	(0.000)	96.048***	(0.000)
Inf	-4.988***	(0.000)	-3.738***	(0.000)	56.595***	(0.001)
Stab	-2.152**	(0.016)	-1.649**	(0.049)	47.334***	(0.006)
Corr	-1.349*	(0.089)	-2.668***	(0.008)	48.381***	(0.004)
Def/Sur	-2.590***	(0.005)	-3.344***	(0.000)	53.357***	(0.001)
Tax	-2.380***	(0.009)	-2.177**	(0.015)	44.849**	(0.012)
Nontax	-1.419*	(0.078)	-1.864**	(0.031)	46.033**	(0.010)

P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

Table A2: Low and middle-income countries panel unit root tests.

	LLC		IPS		ADF-Fisher	
	Level		**Level**		**Level**	
GDP/k	-3.929***	(0.000)	-2.593**	(0.005)	70.909**	(0.006)
DGDP/k	-4.854***	(0.000)	-3.191***	(0.001)	78.345***	(0.001)
Prod	-4.922***	(0.000)	-3.046***	(0.001)	74.886***	(0.003)
Nonprod	-5.277***	(0.000)	-3.700***	(0.000)	75.563**	(0.002)
Env	-3.542***	(0.000)	-4.394***	(0.000)	100.489***	(0.000)
GFCF	-4.544***	(0.000)	-2.937***	(0.002)	78.338***	(0.001)
Inf	-5.866***	(0.000)	-4.226***	(0.000)	106.862***	(0.000)
Stab	-2.789***	(0.003)	-2.265**	(0.012)	65.208**	(0.021)
Corr	-2.144**	(0.016)	-2.586**	(0.027)	59.719***	(0.007)
Def/Sur	-3.088***	(0.001)	-3.714***	(0.000)	90.711***	(0.000)
Tax	-4.088***	(0.000)	-1.765**	(0.039)	56.412***	(0.009)
Nontax	-1.511*	(0.065)	-2.768***	(0.003)	86.495***	(0.000)

P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level

Table A3: High-income countries VIF test for productive spending

Variable	VIF	1/VIF
Tax	4.45	0.225
Nontax	3.47	0.288
Prod	2.54	0.394
Def/Sur	2.28	0.438
GFCF	1.96	0.511
Corr	1.75	0.570
DGDP/k	1.41	0.709
Stab	1.37	0.730
Inf	1.33	0.754
Env	1.26	0.793
Crisis	1.03	0.975
Mean VIF	2.08	

Table A4: High-income countries VIF test for non-productive spending

Variable	VIF	1/VIF
Tax	4.28	0.234
Nontax	3.39	0.295
Nonprod	2.42	0.413
Def/Sur	2.29	0.438
Env	2.09	0.479
GFCF	1.62	0.618
Corr	1.44	0.694
Stab	1.37	0.730
DGDP/k	1.35	0.743
Inf	1.29	0.774
Crisis	1.02	0.976
Mean VIF	2.05	

Table A5: Low to middle-income countries VIF test for productive spending

Variable	VIF	1/VIF
Corr	2.13	0.470
Env	2.02	0.494
Tax	1.93	0.519
Nontax	1.89	0.530
Prod	1.87	0.534
Stab	1.84	0.544
DGDP/k	1.43	0.699
GFCF	1.35	0.740
Inf	1.12	0.890
Def/Sur	1.05	0.953
Crisis	1.02	0.978
Mean VIF	1.60	

Table A6: Low to middle-income countries VIF test for non-productive spending

Variable	VIF	1/VIF
Corr	2.22	0.450
Env	2.12	0.471
Tax	1.98	0.505
Nonprod	1.93	0.517
Nontax	1.93	0.519
Stab	1.83	0.546
DGDP/k	1.43	0.699
GFCF	1.35	0.742
Inf	1.12	0.892
Def/Sur	1.06	0.947
Crisis	1.02	0.979
Mean VIF	1.64	

Table A7 Panel FGLS results

Dependent variable: per capita growth				
	High-income countries (323 observations)		**Low-to-middle income countries (543 observations)**	
	(1)	**(2)**	**(1)**	**(2)**
DGDP/k	0.859***	0.848***	0.886***	0.879***
	(0.000)	(0.000)	(0.000)	(0.000)
Edu	0.301***		-0.090	
	(0.005)		(0.233)	
Health	-0.145**		-0.139	
	(0.048)		(0.116)	
Defence	-0.104		0.020	
	(0.244)		(0.452)	
Housing	0.170		0.126	
	(0.297)		(0.374)	
Affairs	-0.111		-0.113***	
	(0.164)		(0.006)	
General	0.021*		0.027**	
	(0.035)		(0.035)	
Order		0.429***		-0.057*
		(0.000)		(0.014)
Recreation		0.226		0.112
		(0.153)		(0.713)
Social		-0.034		-0.099***
		(0.65)		(0.000)
Env	0.036	-0.242	0.962***	0.936***
	(0.894)	(0.434)	(0.010)	(0.009)
GFCF	0.005	0.005	0.018	0.012
	(0.695)	(0.656)	(0.760)	(0.233)
Inf	-0.025	-0.009	-0.001***	-0.001***
	(0.192)	(0.633)	(0.002)	(0.002)
Stab	-0.001	-0.167	0.223	0.207
	(0.997)	(0.281)	(0.143)	(0.170)
Corr	0.189**	0.121**	0.623***	0.625***
	(0.032)	(0.032)	(0.004)	(0.004)
Def/Sur	0.002	0.001	0.001	0.002
	(0.523)	(0.742)	(0.768)	(0.289)

Tax	0.004	0.003	-0.022*	-0.034***
	(0.295)	(0.337)	(0.074)	(0.006)
Nontax	-0.004	-0.003	0.085**	0.135*
	(0.746)	(0.777)	(0.025)	(0.072)
Crisis	-0.305**	-0.387**	-0.306	-0.294
	(0.039)	(0.027)	(0.347)	(0.367)
No. of countries	13	13	22	22

P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

Table A8 Panel GMM results

Dependent variable: per capita growth				
	High-income countries (323 observations)		**Low-to-middle income countries (543 observations)**	
	(1)	**(2)**	**(1)**	**(2)**
DGDP/k	0.861***	0.848***	0.875***	0.870***
	(0.000)	(0.000)	(0.000)	(0.000)
Edu	0.306**		-0.089	
	(0.021)		(0.277)	
Health	-0.150***		-0.135	
	(0.007)		(0.187)	
Defence	-0.100		0.020	
	(0.320)		(0.456)	
Housing	0.170		0.126	
	(0.438)		(0.369)	
Affairs	-0.107		-0.115**	
	(0.370)		(0.021)	
General	0.028**		0.021**	
	(0.034)		(0.031)	
Order		0.429*		-0.056***
		(0.046)		(0.019)
Recreation		0.226		0.106
		(0.107)		(0.540)
Social		- 0.034		-0.100***
		(0.170)		(0.000)
Env	0.015	-0.242	1.020***	0.949***
	(0.938)	(0.303)	(0.004)	(0.001)

GFCF	0.002	0.005	0.022	0.017
	(0.944)	(0.774)	(0.313)	(0.406)
Inf	-0.024	-0.009	-0.001**	-0.001**
	(0.430)	(0.725)	(0.033)	(0.035)
Stab	0.01	-0.167	0.193	0.196
	(0.969)	(0.196)	(0.234)	(0.234)
Corr	0.179**	0.121**	0.619***	0.629***
	(0.016)	(0.023)	(0.006)	(0.000)
Def/Sur	0.002	0.001	0.001	0.002
	(0.121)	(0.338)	(0.589)	(0.250)
Tax	0.004	0.003	-0.023**	-0.035***
	(0.248)	(0.309)	(0.034)	(0.000)
Nontax	-0.004	-0.003	0.095**	0.144***
	(0.764)	(0.814)	(0.025)	(0.005)
Crisis	-0.305*	-0.387**	-0.304	-0.287
	(0.051)	(0.039)	(0.144)	(0.147)
No. of countries	13	13	22	22
AR(1)	-2.41*	-2.48*	-2.75***	-2.74**
	(0.016)	(0.013)	(0.006)	(0.006)
AR(2)	-1.60	-1.63	-1.39	-1.36
	(0.110)	(0.102)	(0.164)	(0.173)
Hansen test	0.01	0.01	2.86	9.22
	(0.987)	(0.992)	(0.988)	(0.987)

P-value is in parenthesis. *,**,*** denote the statistical significance at 10%, 5%, 1% level.

Table A9 Nonproductive spending descriptive statistics (in percentage of nonproductive spending)

Variables	High income countries (323 observations)		Low and middle income countries (543 observations)	
	Mean	Standard deviation	Mean	Standard deviation
Order	17.731	8.416	20.850	21.303
Recreation	9.225	8.008	6.051	4.109
Social	73.044	57.981	73.099	49.609

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Figures

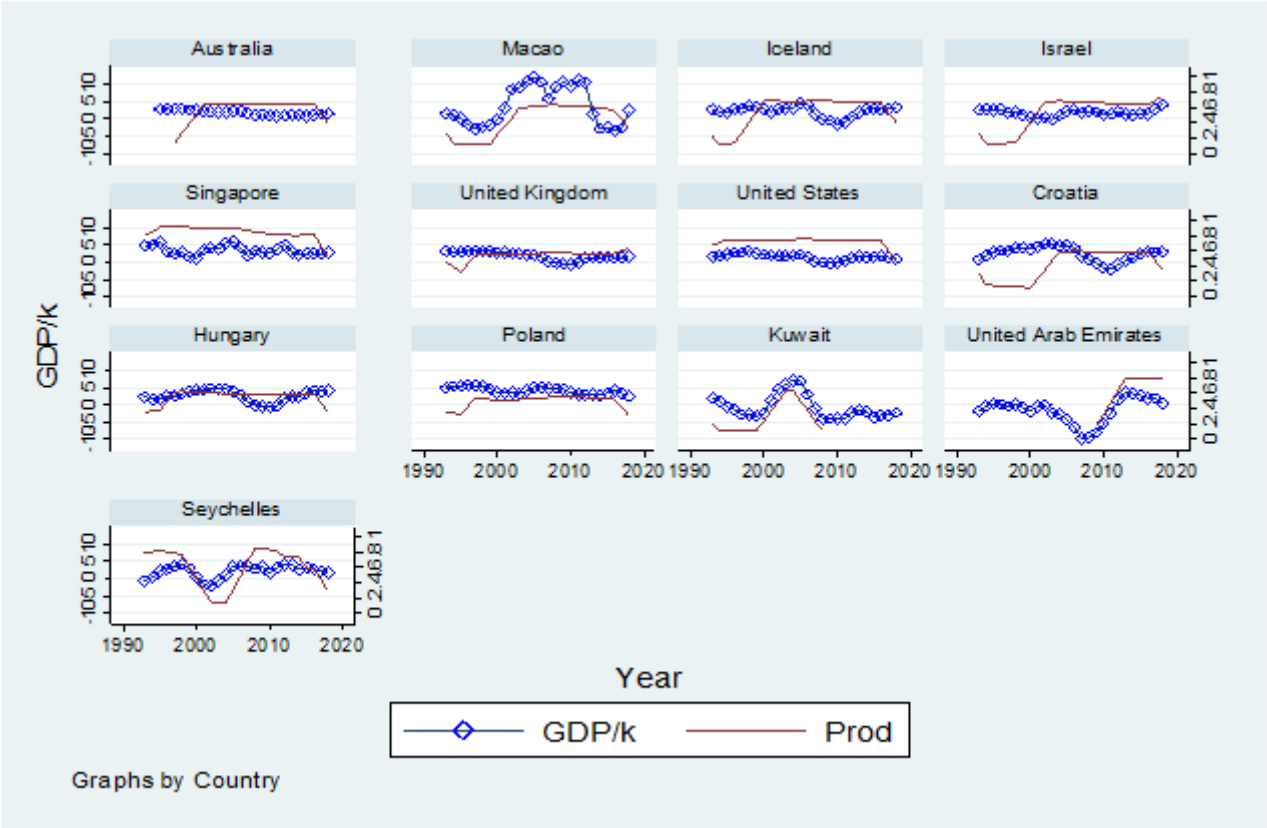

Figure 1

Productive spending and growth in high-income countries

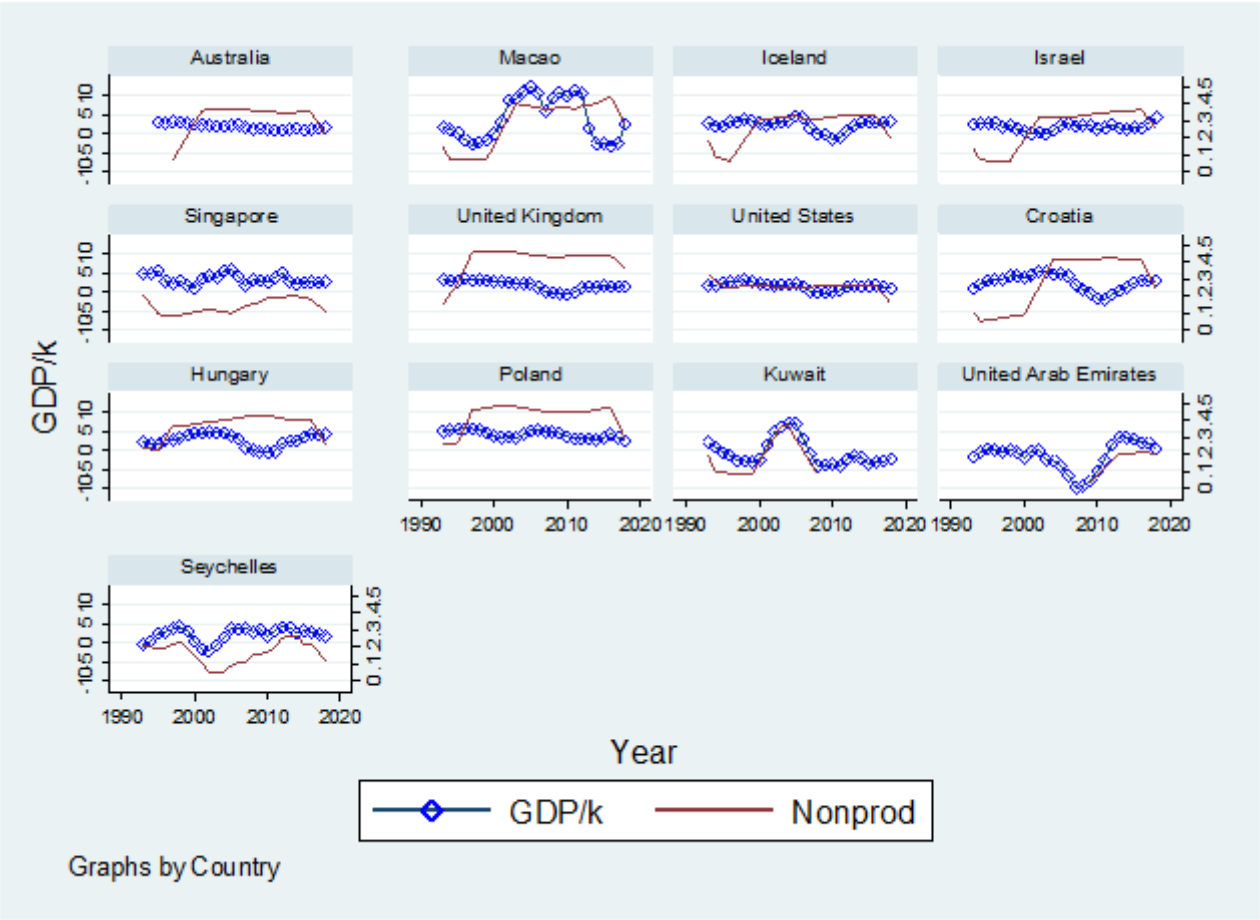

Figure 2

Nonproductive spending and growth in high-income countries

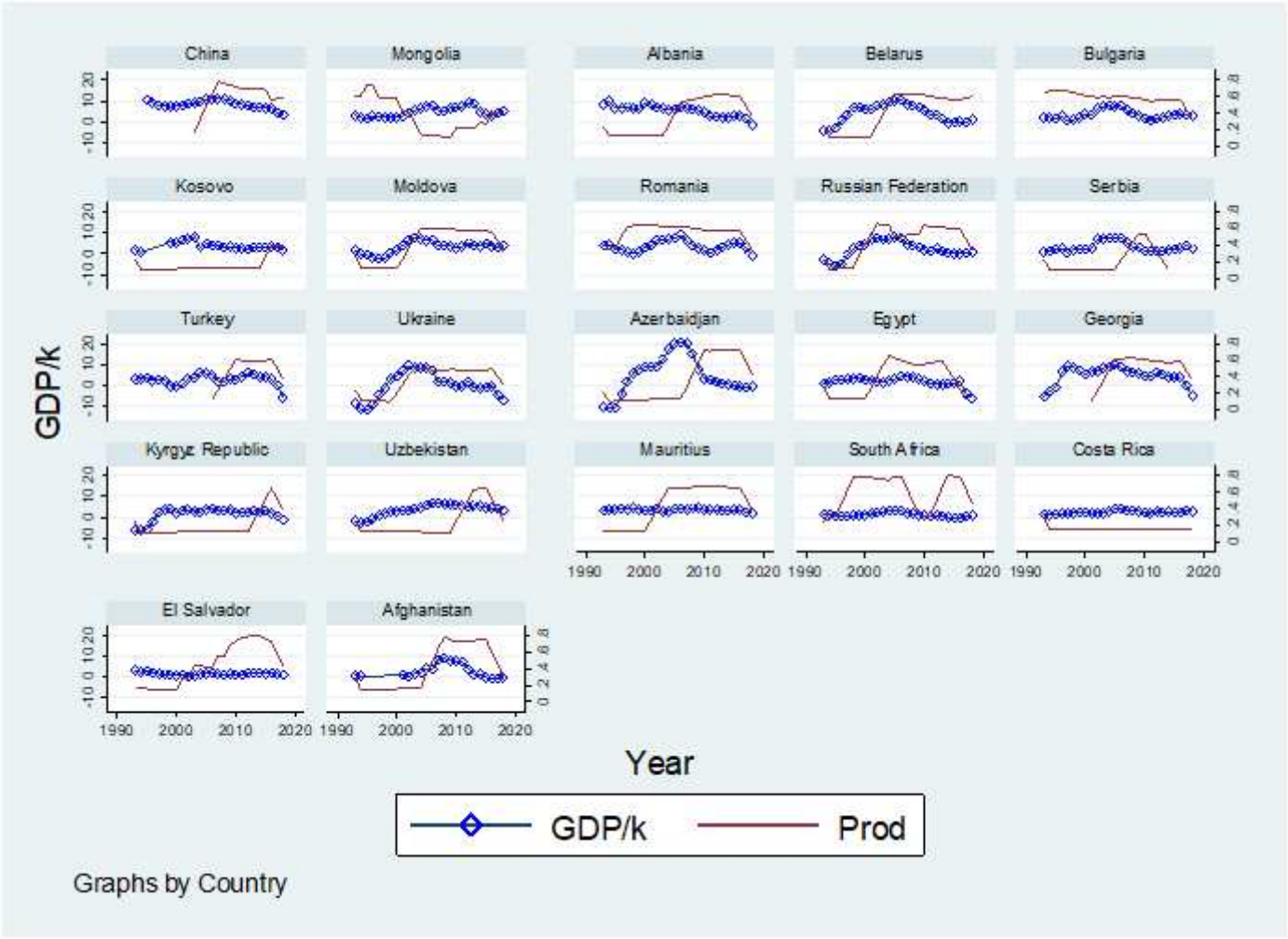

Figure 3

Productive spending and growth in low and middle-income countries

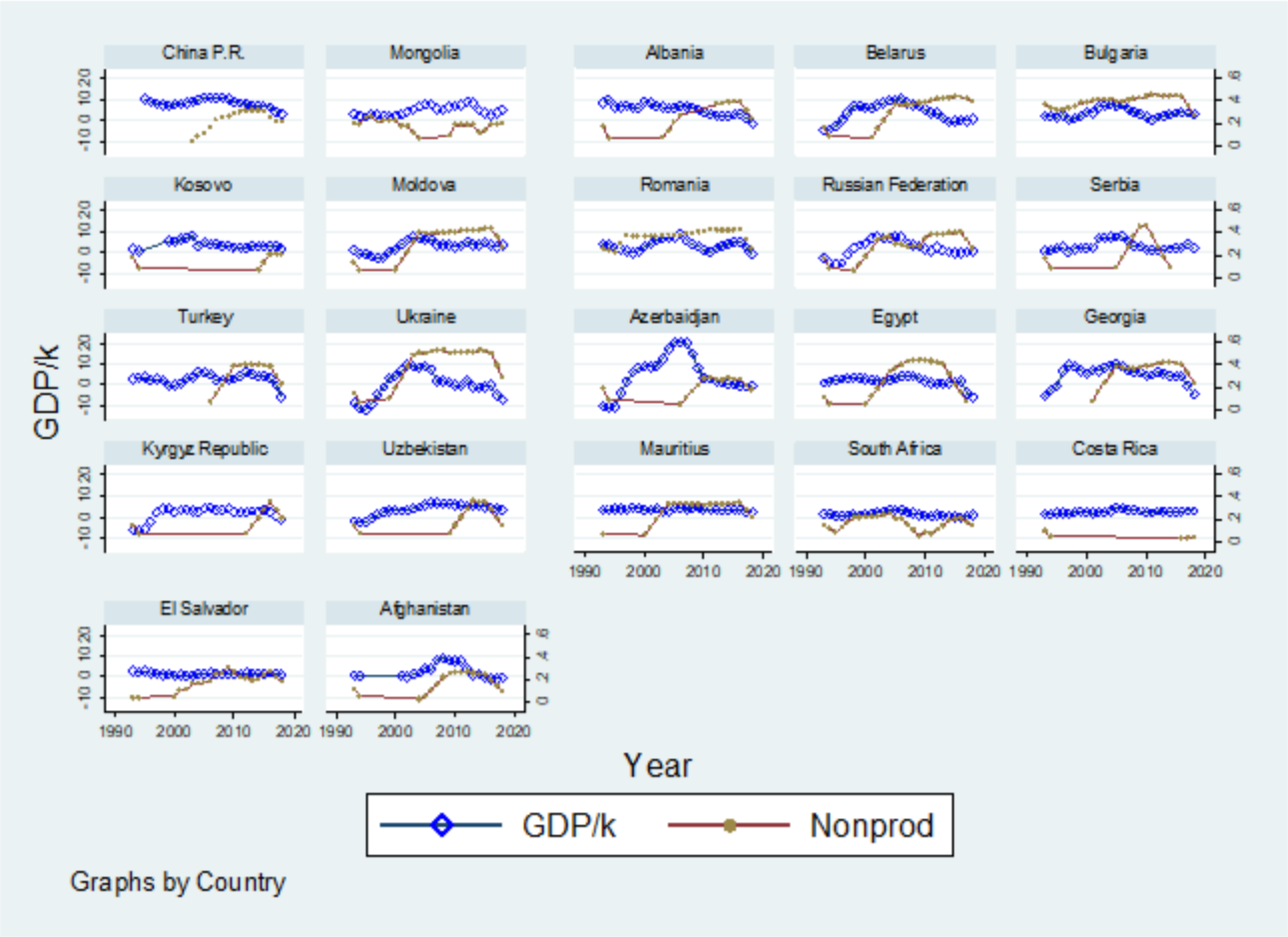

Figure 4

Nonproductive spending and growth in low and middle-income countries