Government Expenditures and Economic Growth: A Nonlinear Causality Investigation for the UK

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Abstract

This study aims to explore the causal relationship between government expenditures and economic growth in the UK. The analysis emphasizes on the nonlinearity facet of the explored causality. In this aspect, existing conditional heteroscedasticity as a potential source of bias, is filtered out with the use of the nonparametric Diks and Panchenko causality test. The UK government expenditures are disaggregated into total managed expenditure (TGE), current expenditure (CGE) and net investment (IGE), in order to account for a possible heterogeneity in a causality disclosure linked to the nature of expenditures. The findings support that UK government spending Granger causes nonlinearly UK economic growth. Overall, government spending at all three levels of disaggregation is documented to influence the economic growth in the UK. In this aspect, the results move along with the endogenous growth literature. However, in a policy making framework, the disclosed nonlinearity patterns stress the high risk involved whenever economic growth is pursued restrictively via public spending policies overlooking other important elements of the economic life (e.g. market structure, macroeconomic environment, etc.). Additionally, the exhibited nonlinearity in the examined causality could be regarded as a likely cause of the widespread diversification of the findings in the field empirical literature.

Keywords: Nonlinear causality, Economic growth, Government expenditures, UK

1. Introduction

Government expenditures can contribute to a country's economic output both positively and negatively. Apparently, as the advocates of the Leviathan public choice school support, a large public sector by providing a reasonable amount of public goods and services (e.g. infrastructure projects, health, education, social security, welfare, defence services, etc.) a government can boost economic growth and influence positively the productivity in the private sector. However, a large public sector financed by taxes or external borrowing can result in a disproportionate size of governmental interventions in the economic life via overpriced public goods and services, often coupled with 'unproductive' or even rent-seeking, activities that finally undermine the envisaged economic growth prospects.

Undoubtedly, during the last decades, the appropriate size of public sector which would optimally stimulate a country's economic growth has become the research subject for numerous studies. The relationship between government spending and economic growth constituted a favourite topic of discussion in both neoclassical and endogenous growth theories. In the empirical literature, discussing the government spending-economic growth relationship, Grossman (1988) is the first who introduces the feature of nonlinearity. In endogenous growth theory, a distinguished model discussing the nonlinearity aspect of the above relationship is that of Barro (1990). The model presents a theoretical concave, static relationship between the economic growth rate and the size of a government. The later with the form of the ratio of productive government expenditures to GNP has been modified in an economic growth optimization process. In the same line, the so-

called Rahn Curve[1] quantifies the optimal level in government spending but avoids disaggregating it according to the type of public activities. Also, Scully (1998, 2003) extends the theoretical Barro model (1990) revealing a trade-off between economic growth and income inequality.

In this study, the H_0 hypothesis is whether public spending - in the form of total managed government expenditure, current public expenditure and public net investment - Granger causes UK economic growth in a nonlinear way during the period 1955-2009. The study offers empirical findings that underscore the feature of nonlinearity that was initially introduced in the long-run relationships of the Grossman (1988) and Barro (1990) studies. An innovative feature lies in use of the Diks and Panchenko (2006) test-instead of the frequently used Hiemstra-Jones (1993, 1994) test[2]- in order to account for the false nonlinearity due to the existing heteroskedasticity.

The paper is organised as follows: Section 2, sets the theoretical framework for the nonlinear relationship. Section 3, presents the nonparametric Diks and Panchenko causality test. Section 4, describes the data and the empirical results, and section 5 concludes.

2. Theoretical framework

According to the neoclassical theory of economic growth, taxes only temporally influence the growth rate of income in the transition to successive equilibrium growth paths, whereas, technological progress and population dynamics are exogenous forces that can lead to a steady-state equilibrium growth. On the contrary, the endogenous growth theory accepts that a steady-state growth is determined by the agents of the economy. Consequently, taxes are assumed to influence permanently the steady-state growth, by affecting parameters such as the value of investments in R&D and the rate of return on capital accumulation.

In very broad lines, the studies around the government expenditure-economic growth nexus could be grouped into the following categories according to their findings: a) in studies concluding on mixed or arriving to inconclusive results on the sign and size of this relationship (e.g. Nelson and Singh 1994; Agell *et al*. 1997; Ansari *et al*. 1997; Al-Faris 2002; Kollias and Paleologou 2010[3]; Germmell and Au 2013; Afonso and Jalles 2014, etc.), b) in studies that conclude on a negative relationship (e.g. Barro 1991; Engen and Skinner 1992; Guseh 1997; Burton 1999; Fölster and Henrekson 2001; Lee and Gordon 2005; Yavas 1998, Bergh and Henrekson 2011, etc.), c) in studies that conclude on a positive relationship (Aschauer 1990; Kelly 1997; Blanchard and Perotti 2002; Colombier 2009, Pereira and Roca-Sagale's 2011, etc.) and, d) in studies concluding in a inverted U shaped relationship (e.g. Barro 1990; Armey and Armey 1995; Rahn and Fox 1996; Scully 2003, Carboni and Medda 2011, etc.).

In this paper, additionally to other discussed causes[4], we illustrate also the predominant facet of nonlinearity as a plausible cause of the findings' diversification and controversy among the field studies. Specifically, we investigate the nonlinear relationship between public spending and economic growth using a new nonlinear Granger causality model in order to account for the likely mixed positive and negative growth effects in the UK economy. Nonlinear causality refers to the disproportional effect between government spending and economic growth. This disproportionality is related to the stand of fiscal policy (e.g. expansionary or restrictive fiscal policy) and the asymmetric shifts in economic policy regimes over time. Additionally, the need to uncover nonlinear dependencies is highlighted by the fact that even in cases when a linear Granger causality is witnessed, nonlinear dynamic dependences can not be necessarily excluded (see Kyrtsou and Labys 2006).

The study's empirical findings suggest that public spending affects economic growth in a nonlinear way. Thus, the causality effect, though strong and clear, is non-proportional and uncontrollable as to the sign and the magnitude. Possible reasons might be looked for in the nature of expenditures, the current level of GDP, political reasons (e.g. elections, shifts in

[1] See Brimelow (1993).
[2] The Hiemstra-Jones (1993, 1994) test is a modified version of the Baek and Brock (1992) test.
[3] Kollias and Paleologou (2010) investigate the relationship between growth, investment and military expenditure.
[4] In the field empirical literature there exists a large spectrum of arbitrage and controvercy in the decisions touching upon the selection of: the appropriate level of public data series (dis)aggregation and heterogeneity (e.g. according to the category of expenses, the level of economic development of the examined economies, etc.), the time spam considered (e.g. short run shocks vs. long run effects, etc.), the selection of the appropriate exogenous variables for the modelling process (e.g. expenditures vs. taxes,etc), the selection of appropriate modelling process (e.g. Time series vs. panel models, etc.), etc.

economic policy) etc. Recalling Agell et al. (1997): '*what we somewhat carelessly refer to as the public sector is in fact a microcosm, which includes everything from the choice of tax bases and setting of tax rates to decisions concerning public consumption programs and social insurance compensation levels'.* In the same strand, Myles (2000) concludes that, government spending may just be a proxy for the entire set of government non-price interventions, including, for instance, employment, legislation, health and safety rules and product standards and it may be these, instead of the expenditure, that actually reduce growth.

In general terms, our findings move along with the claims of the endogenous growth theorists in that public expenditure affects economic growth in a nonlinear and permanent way. Whereas no assumptions can be made on the sign of the effects, the study findings could be seem as highlighting the risk involved in the policy practices targeting economic growth via expansionary public spending and a Leviathan public sector. Similarly however, there is a high risk for disproportional economic growth effects when a restrictive public policy is enforced under the light of budgetary constraints. Subsequently, it expands the relevant empirical literature by uncovering the complex, dynamic nature of the public spending-economic growth relationship. From a policy making perspective, the presence of a nonlinear Granger causal flow renders policy makers unable to forecast the exact size and the direction in an economic growth change caused by public spending changes or reallocation. Summing up, public spending, despite its definite growth determinant role, could be modified (increased, decreased or reallocated into the various public activities) with caution and only after controlling for a wider set of policy measures (e.g. tax law enforcement power, corruption, minimization of rent seeking activities, penetration of Information Technology, incentivisation of the private-sector investments, etc).

3. The nonparametric Diks and Panchenko causality test

In 1969, Granger proposed a causality test to describe the dependence relations between economic time series. According to this, if two variables - gross domestic product $\{GDP_t\}$ and government expenditures $\{GE_t\}$, where $t \geq 1$ - are strictly stationary, $\{GE_t\}$ Granger causes $\{GDP_t\}$ if past and/or current values of *GDP* contain additional information on future values of *GE*. Suppose $F_{GDP,t}$ and $F_{GE,t}$ denote the information sets consisting of past observations of GDP_t and GE_t for time *t*. $\{GE_t\}$ Granger causes $\{GDP_t\}$, if:

$$(GE_{t+1},\ldots,GE_{t+k})|(F_{GDP,t}, F_{GE,t}) \quad (GE_{t+1},\ldots,GE_{t+k})|F_{GE,t} \quad (1) \quad \sim$$

where '~' denotes equivalence in distribution and $k \geq 1$. However, in practice $k = 1$ is more oftenly used. In this case, Granger non-causality can be tested by comparing the one-step-ahead conditional distribution of $\{GE_t\}$ with and without past and current observed values of $\{GDP_t\}$. In order to test for Granger causality, we consider a bivariate stationary time series model with a mean $E(GE_{t+1}|(F_{GDP,t}, F_{GE,t}))$. We compare the residuals of a fitted autoregressive model of GE_t with those obtained by the regression of GE_t on past values of $\{GDP_t\}$ and $\{GE_t\}$ (Granger 1969). The test statistic is:

$$T_n(\varepsilon_n) = \frac{n-1}{n(n-2)} \cdot \sum_i \left(\hat{f}_{GDP,Z,GE}(GDP_i, Z_i, GE_i)\hat{f}_{GE}(GE_i) - \hat{f}_{GDP,GE}(GDP_i, GE_i)\hat{f}_{GE,Z}(GE_i, Z_i) \right)$$

(2)

where $Z_i = GE_{i+1}$, $f_{GDP,Z,GE}(gdp,z,ge)$ the joint probability density function, ε_n the bandwidth and *n* the sample size[1].

For $l_X = l_Y = 1$ and if $\varepsilon_n = Cn^{-\beta}\left(C > 0, \frac{1}{4} < \beta < \frac{1}{3}\right)$, Diks and Panchenko (2006) prove that the test statistic in equation (2) satisfies the following:

$$\sqrt{n}\frac{(T_n(\varepsilon_n) - q)}{S_n} \xrightarrow{D} N(0,1) \quad (3)$$

[1] The bandwidth ε_n values are set according to table 1, p. 1658, from the Diks and Panchenko (2006) paper. For $100<n<500 \Rightarrow \varepsilon_n=1.5$

where $\xrightarrow{D}$ denotes convergence in distribution and S_n is an estimator of the asymptotic variance of $T_n(\cdot)$ (Diks and Panchenko 2006 and Bekiros and Diks 2008). In this study, following the Diks and Panchenko's suggestion, we implement a one-tailed version of the test.

4. Data and Empirical results

4.1 Data and Preliminary Analysis

The study is carried out using quarterly data covering the time period 1955:1 to 2009:1 for the UK. GDP stands for the gross domestic product, TGE for the total managed expenditure of government, CGE for the public sector current expenditure and IGE for the public sector net investment. The disaggregation of total government expenditures is crucial for the appropriate isolation of the source of a likely nonlinear causal relationship. The distinction of government expenditures into public sector current expenditure and public sector net investment, serves to decomposing the likely uneven nonlinear growth causality effects. Similarly other studies in this field, e.g. Angelopoulos *et al*. (2007) which built upon Barro (1990) and Baier and Glomm (2001) have accounted for the uneven growth effects of public expenditure by distinguishing them to "*productive*" and "*non-productive*", following the Kneller *et al.* (1999) classification. Additionally, Angelopoulos *et al*. (2007) suggested that OECD countries could improve their growth performance by reallocating public spending towards productive activities.

Presumably, each category of government expenditures displays unequal increases than others and contributes in a different way to economic growth. Hence a potential nonlinear flow that may be detected between government spending and economic growth could result from a specific category of government expenditures. For this reason, the analysis includes government spending both at the aggregate and the disaggregate level. All data are obtained from the Office for National Statistics Database in the UK and they are expressed in current prices[1] and logarithms.

The use of the Diks-Panchenko nonlinear causality test is justified by the presence of high kurtosis value[2], suggesting heteroskedasticity structures in data sets (Diks and Panchenko 2006). In the first place, the unit roots have been removed to obtain stationary series (Dickey and Fuller 1979). Furthermore, any linear dependence should also be removed. For this purpose, we apply a Vector Autoregression (VAR) model and use the estimated residuals to test for nonlinear causality. If GE_t is the vector of government expenditures and p the number of lags, the VAR model is the following:

$$GE_t = \sum_{s=1}^{p} A_s\, GE_{t-s} + \varepsilon_t \qquad (4)$$

where $GE_t=[GE_{1t}, \ldots, GE_{lt}]$ is the px1 vector of endogenous variables (t=1,2,…, T), A_s is the pxp parameter matrix and ε_t a white-noise error vector. Five lags have been used in all three cases. The results from the estimation of the VAR model reveal the significance of the VAR model coefficients[3].

4.2 Empirical results

The nonlinear Granger causality test (Diks and Panchenko 2006) is applied on the estimated residual series of the VAR model. The test has been applied in both directions for $L_x=L_y=1, \ldots, 5$[4] and for bandwidth $\varepsilon=1.5$, which has been set according to the time series length n. Table 1 shows the resulting T-statistics and p-values of the Diks-Panchenko testing.

The results obtained from the test provide clear evidence that UK government expenditure Granger causes nonlinearly UK economic growth. More specifically, the nonlinear Granger causality running from current government spending to GDP is

[1] The use of current prices is incumbent in the case nonlinear causality tests are applied. This is because the transformation in constant prices could act as a filter producing distortions, especially when the underlying mechanism generating data is nonlinear.
[2] Because of space considerations, detailed tables are available from the authors upon request.
[3] ibid.
[4] $L_x=L_y$ denotes the number of lags on the residuals series used in the test.

evident with 1-2 lags, while total government spending and public investment significantly Granger causes GDP with lag orders of 1-5.

Table 1. Results for the NonLinear Causality Test

$L_x=L_y$	TGE → GDP		CGE → GDP		IGE → GDP	
	T- statistics	*p*-value	*T*- statistics	*p*-value	*T* -statistics	*p*-value
1	2.204	0.01375**	1.535	0.0624*	-3.927	0.00004***
2	2.355	0.00926***	2.641	0.00413***	-5.13	0.00000***
3	2.242	0.01248**	1.025	0.15272	-4.326	0.00001***
4	1.546	0.06105*	0.947	0.17171	-3.535	0.00020***
5	1.666	0.04783**	1.152	0.12467	-2.662	0.00388***

Notes: GDP stands for the Gross Domestic Product, TGE for the total managed expenditure of government, CGE for the public sector current expenditure and IGE for the public sector net investment.
The null hypothesis suggests that TGE/ CGE /IGE, respectively, does not cause GDP.
*** denotes *p*-value statistical significance at 1% level, ** denotes *p*-value statistical significance at 5% level, * denotes *p*-value statistical significance at 10% level.

The existence of nonlinearity might be caused by several economic and political factors. UK's economic policy has been asymmetric during the period under examination, inducing changes in fiscal policy parameters, particularly government spending and taxation. The shifts in fiscal policy – for example, towards a more restrictive regime in the early '80s - appear as a response to the unfavourable at that time macro and micro economic environment (i.e. unemployment, potential impact of oil crisis etc.).

From the economic theory perspective, the findings are in line with the endogenous growth theory. Although they disclose the endogenous effect of fiscal tools (such as the change in government expenditures in this study) on GDP growth, they underscore, in a non-quantitatively way, the feature of fragility in the government expenditure-GDP growth causality effect. The later proves that public expenditure changes turn to be an incomplete fiscal policy tool on economic growth grounds.

Additionally, the findings uncover the short-run dimension in this relationship that departs from the static nonlinear government expenses–GDP growth models' framework (e.g. described first in Barro 1990). They highlight the risk when a government struggles to boost a country's economic growth, for example by restricting public expenses and public investments (i.e. the shift into a restrictive fiscal environment in the UK in early '80s).

As it has been pointed out in Grossman (1988), increases in government are asymmetrically related with changes in total economic output, allowing shocks in one variable to impact either positively or negatively the other. Thereby, this asymmetric relationship has been taken into account in a parametric model which by construction captures the nonlinear nature of the dependence. In economic terms, the presence of nonlinearity in the aforementioned setting is justified by the magnitude and, most importantly, the causes of the resulting negative effects due to the increased involvement in the private sector. The situation can worsen due to behavioural bias of taxpayers that undergo the effects of an increasing burden.

According to Olson (1982), the complex characteristics of the process of distributional coalitions determine the efficiency of regulation and the role of government. It is argued that rent-seeking activities are capable to act as an expanding mechanism of inefficiencies. This inherent heterogeneity, due to the presence of that various "unproductive" social groups, is accused to fuel the nonlinear effect of government spending and, thus, final inefficiency in achieving optimal output level. The observed heterogeneity also forces rises in spending, leading government to actively intervene. Grossman (1988) underlines that the dispersion of this spending into heterogeneous recipients puts in peril the efficiency of the intervention.

5. Conclusion

The present study aims to shed light on the government spending – economic growth causality. The distinctive feature of this study is that it employs the nonparametric Diks and Panchenko causality test to explore the nonlinearity facet of the relationship between the examined variables.

The empirical results uncover a nonlinear causal relationship between the government spending and the economic growth in the UK. The feature of nonlinearity in the causal effect, could be attributed either to economic and political factors (such

as the stand and shifts in fiscal policy and specificities of the internal market structure) or to pathogenic features in public sector functioning (i.e. corruption, bureaucracy, rent seeking, low enforcement power, etc.) that could hamper the efficiency of implemented fiscal policies.

Apparently, in policy terms, the presence of a nonlinear Granger causality renders policy makers unable to forecast the exact size or even direction of the economic growth changes triggered by monotonic public spending policies.

Additionally, in empirical methodology terms, the predominant non linearity facet of the examined relationship constitutes a possible source of misspecification issues in the modelling process and a possible cause of the ample disparity of the findings in the field empirical literature.

In total, public spending definitely constitutes an exceptionally influential economic growth driver however, its reliability as a policy instrument should be regarded with duly scepticism due to the co-existence of economic growth hampering agents (e.g. low law enforcement power, corruption, bureaucracy, rent seeking activities, disinsentivising of private investments, inefficient market structure, unfavourable macroeconomic environment, etc.), challenging its applicability and occasionally its appropriateness.

Disclaimer: The views and opinions expressed in this paper are those of the authors and do not necessarily reflect the official position of the affiliated institutions

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