Unwanted side effects of Baumol's cost disease on a balanced-budget rule

(Draft version)

by

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Abstract

Based on a panel of 24 OECD countries this present paper shows that the total government sector is contracted by Baumol's cost disease. The most affected government services are education and healthcare. Furthermore, this paper shows that Baumol's cost disease produces adverse consequences under a balanced budget rule such as a debt brake, which is a key element of the EU Fiscal Compact. Governments face a serious dilemma. Breaching the rule would certainly cause reputational losses for governments, which might affect their borrowing costs. Adhering to the balanced-budget rule means risking budget-crowding out of cost-disease affected public expenditure with an ensuing long-run deterioration of these services and/ or foregoing growth opportunities. Governments of the EU member states and EU policy makers should therefore revise the EU Fiscal Compact to reconcile it with Baumol's cost disease. Additionally, we apply an innovative statistically robust estimation method, which is particularly suited to deal with the distinct heterogeneity of panel datasets.

JEL code: H50, H62, H63, C23

Key Words: Baumol's cost disease, balanced budget rule, economic growth, composition of public expenditure, robust estimator.

1. Introduction

A major drawback of balanced budget rules such as the one of the Fiscal Compact of the European Union (EU) is that the impact of exogenous determinants such as population ageing and Baumol's cost disease is not taken into account. The ageing effect and its consequences for fiscal rules are fully acknowledged (European Commission, 2015). Although many government services such as healthcare, education or the performing arts are supposed to suffer from Baumol’s cost disease, apart from an early discussion, the working of Baumol’s cost disease under fiscal restraints has so far been neglected in the literature (Baumol and Oates, 1979; Baumol 1985; Ryan, 1992). The absence of a discussion is even more surprising as a key issue in the EU revolves around generating economic growth in the EU crisis countries. This present paper fills this gap by analysing the impact of the cost disease under a balanced-budget rule and by providing evidence for the relevance of Baumol’s cost disease for government expenditures decomposed by function. Thus, this present paper draws the attention to an important economic-policy issue pertinent to the new fiscal framework of the European Union.

Our main finding is that Baumol’s cost disease produces a serious dilemma for governments who have implemented a balanced-budget rule. Governments have the choice between Scylla and Charybdis. Either governments risk reputational losses by breaching the balanced-budget rule or a budget crowding out, in particular, of cost-disease affected government expenditures and/ or missing out on growth opportunities. In the long run, cost-disease caught government services might even deteriorate. We carry out a comprehensive empirical analysis of the impact of Baumol’s cost disease on the composition of government expenditure. Our results suggest that government expenditure, in particular, those on total government, health and education and to a lesser extent on recreation, culture and religion are affected by the cost disease.

The few somewhat related empirical studies focus on the impact of Baumol’s cost disease on health (Hartwig, 2008; Bates and Santerre, 2013; Rossen and Farroque, 2016, Colombier, 2017), public education (Ryan, 1992; Chen and Moul, 2014; Nose, 2015) and government output (Bates and Santerre, 2015). In line with our findings, these studies provide evidence for the relevance of the cost disease in the respective sectors. Ryan (1992) gives some indication that fiscal restraints for the cost-disease-affected public education sector led to a reduction in higher education in 10 OECD countries in the 1970ies and 1980ies. A further study related to this present work by Dahan and Strawcyzinski (2013) analyses the impact of several types of fiscal rules such as the Stability and Growth Pact (SGP) on the composition of government expenditures. Dahan and Strawcysinski (2013) decompose government expenditure by consumption, investment and social transfers. They provide evidence for a budget crowding out of social transfers by government consumption under fiscal rules. This finding, however, does not apply to countries with a strong legal commitment to social rights. To sum up, budget crowding out may occur due to factors endogenous to the political system under fiscal rules. Note that this present study takes another stance because we analyse in which way an exogenous determinant of government expenditure, Baumol's cost disease, can affect the working of a certain type of fiscal rules.

To estimate the impact of Baumol's cost disease on government expenditure we apply an innovative approach, developed by Hartwig (2008) and Colombier (2017), the Baumol variable. This approach avoids using deflators of government services, which are notoriously difficult to calculate (Grilich, 1992). By definition market prices are not available for government services and it is difficult to adjust prices or deflators for quality changes (Bates and Santerre, 2015).

In the field of economics often non-high quality data are available, which can cause the widely used least squares estimators (LSE) to become inefficient and biased. Therefore, some authors propose applying robust statistical methods in economics (Temple, 2000, Zaman et al., 2001, Colombier, 2009). Since robust estimators are not as sensitive to outliers as LSE, they are able to identify the most coherent part of a data set. This ability proves very beneficial to analyse panel data due to the distinct heterogeneity of panel-data sets. Therefore, some authors strongly recommend using robust statistical methods to analyse panel-data sets (Aquaro and

Cizek, 2013; Verardi and Wagner, 2011). Following this recommendation, we apply an outlier-robust estimation method to study the impact of Baumol's cost disease on government expenditure by function.

This paper is organised as follows. The next section sets out the concept of a balanced budget rule. In section 3 we show how Baumol's cost disease can impact the working of a balanced budget rule. Section 4 outlines the estimation approach. In section 5, the empirical results concerning the impact of Baumol's cost disease on government expenditure decomposed by function are presented. Finally, section 6 concludes.

2. The concept of a balanced budget rule

In the wake of the Euro crisis, EU leaders have implemented several reform measures to strengthen budgetary discipline in the EU by tightening the rules of the Stability and Growth Pact (SGP) as part of the Euro-Plus-Pact and introducing a new Fiscal Compact, being the cornerstone of the Treaty on Stability, Coordination and Governance in the Economic and Monetary Union (TSCG) (see EU-Memo/11/ 647, TSCG, 2012). While the revised version of the SGP already encourages the implementation of national fiscal rules such as the German debt brake, Article 3(2) of the TSCG obliges the signatory countries to implement a debt brake, i.e. a balanced-budget rule, in national law.[1] The main elements of the Fiscal Compact can be summarised as follows:

- In accordance with the SGP the rule obliges signatory countries to define a medium-term objective for the structural budget balance that does not exceed a structural deficit of 0.5% of GDP. Only if the public debt ratio is well below 60% of GDP, governments are allowed to have a structural deficit of 1% of GDP. If a government does not meet the medium-term objective, the respective government has to

[1] Note that all EU countries signed the TSCG except for the United Kingdom and the Czech Republic.

implement measures to ensure rapid convergence towards the medium-term objective.

- Temporary deviations from the medium-term objective due to events outside the control of the respective government such as a natural disaster, global financial crisis or severe economic downturn are allowed. Moreover an automatic correction mechanism is foreseen if a country deviates significantly form the medium-term objective or the path towards it.
- The benchmark for the government-debt-to-GDP ratio is the 60%-criterion given by the SGP. Following the rules of the SGP, a government should reduce the public-debt ratio at a velocity of one-twentieth annually, if their debt-ratio is above the 60% limit.

To show how Baumol's cost disease can interfere with the working of a debt brake, as a reference point, we use the German debt-brake rule. The German debt brake has been serving as a blueprint for all the signatory countries of the TSCG. Debt brakes are framed against the background of the (new) neo-classical synthesis (see Colombier, 2006, 529). The debt brake aims at stabilising nominal debt over the business cycle, but budget movements due to cyclical fluctuations should be taken into account. According to neo-classical theory, fiscal policy can smooth the business cycle but is not able to enhance the long-run production possibilities of an economy. On the contrary, a too high debt-level may cause uncertainty among consumers and investors, which in turn causes interest rates to rise and as a result, crowd out private investment. Therefore, the structural government budget should be balanced over the business cycle under a debt brake. However, since the advent of endogenous growth theory several studies show that certain kind of government spending such as educational or infrastructure expenditure can be growth-promoting (e.g. Colombier, 2009). To consider this possibility, at least to some extent, the German debt break allows for a small structural deficit of 0.35% of GDP at the federal level.

In contrast, the states (the *Länder*) are not allowed to run a structural deficit.[2] The overall limit of a structural budget deficit is in the spirit of the SGP, which foresees a close-to-balance budget over the business cycle. According to the SGP, the structural budget deficit must not exceed 0.5% of GDP. The German debt brake is enshrined in the German constitution (see Art. 109 and 115 Grundgesetz).

Moreover, according to conventional wisdom discretionary fiscal policy have severe shortcomings. First, due to the democratic decision process usually fiscal measure are implemented too late and may not be efficiently composed due to strong lobby groups. Second, incentives given to policy-makers or civil servants to enlarge their influence and power may lead to a deficit bias of the government sector. Nonetheless, to smooth the business cycle automatic stabilisers such as the unemployment insurance should be able to work. After a transition period that started 2011, the German debt brake has fully come into force at the federal level in 2016. At the federal level, apart from a structural component the debt brake contains a cyclical component, which allows the automatic stabilisers to work. To give policy-makers limited flexibility the federal government can exempt from the rule under exceptional economic conditions such as a financial crisis or natural catastrophes. Along the lines of the SGP, financial transactions such as revenues for privatisation of public assets or loans to the unemployment insurance are excluded from the calculation of the deficit ceiling.[3]

In the following, a government budget identity in terms of nominal GDP (pY) is shown.

$$g_y + i\, b \equiv \tau + \Delta b \qquad (1)$$

with: g_y := ratio of primary public expenditure to pY

τ:= ratio of public revenues to pY.

[2] Note that the German states should have their own debt brakes implemented by 2020. Apart from the binding constraint of a balanced structural budget the states have some leeway to formulate their debt-brake rules. In particular, the states can choose if their rule permits the budget to fluctuate with the business cycle. For a detailed overview see Deutsche Bundesbank (2011).

[3] A further key component of the German debt brake is the control account, which takes forecast errors for government revenues into account. For a detailed description see Deutsche Bundesbank (2011).

b:= ratio of outstanding stock of government debt to pY

Δb:= new bonds issued in the current period in terms of pY

i:= nominal interest rate on government bonds

As governments in developed economies such as the EU-countries are usually not allowed to finance their deficits by printing new high-powered money, a public deficit can be financed either by tax revenues or by issuing new bonds. Under the debt brake, a limit is placed on the issuing of new bonds. This deficit ceiling can be written as follows:

$$\Delta b_c \leq \sigma - \varepsilon\, (Y-Y^{pot})/Y^{pot} \qquad (2a)$$

with: Y^{pot}:= potential real GDP

$(Y-Y^{pot})/Y^{pot}$:= output gap in real terms

ε:= budget sensitivity with respect to a 1%-change of the output gap

σ:= structural deficit limit, for Germany: 0.35% of nominal GDP

Under the debt-brake rule the deficit ceiling (Δb_c) is calculated as the sum of a structural component (first term on the right-hand side (rhs) of equation (2)) and a cyclical component (second term on the rhs of equation (2)) of the government budget. Since we are interested in how Baumol's cost disease affects the working of the balanced-budget rule, we assume that the economy is in a long-term equilibrium so that the output gap vanishes i.e. $Y=Y^{pot}$. As a result, the deficit ceiling given by the debt brake reduces to:[4]

$$\Delta b_c \leq \sigma \qquad \text{with: } 0 < \sigma \leq 0.05 \qquad (2b)$$

Inserting the deficit ceiling in equation (1) and rearranging this equation leads to the following term:

$$g_y \leq \sigma + \tau - ib \qquad (3)$$

Unless the government is willing to increase taxes, the sum on the rhs of equation (3) is given. Consequently, a debt-brake rule imposes a limit on the ratio of the primary public

[4] The maximum structural deficit allowed under the SGP corresponds to 0.5% of GDP.

expenditure to GDP in the long run. However, this can lead to adverse consequences if the government sector is contracted by Baumol’s cost disease as we show in the following.

3. Baumol's cost disease under a balanced-budget rule

3.1 Baumol's model of unbalanced growth

Baumol’s cost disease is based on the assumption that an economy can be decomposed into sectors that are characterised by technologically progressive activities such as capital accumulation, process innovations and economies of scale, which brings about a steady increase in labour productivity, and sectors that are characterised only by occasional productivity growth (see Baumol, 1967, 415-16). The quality of labour is key to the quality of products in these sectors. Labour is difficult to substitute with capital in these sectors so that labour-augmenting (Harrod-neutral) technical progress is hampered. Baumol (1993, 17-18) quotes healthcare, education or the personal services such as automotive repair as prime examples for these non-progressive or stagnant industries (Baumol sector). Provided that the demand for the non-progressive sector is price inelastic or is subsidised by the government, the demand for labour in these sectors increases steadily. In order to avoid labour shortages in the long run in the Baumol sector, wages of this sector have to increase with the wages in the progressive sector of the economy such as manufacturing. The latter are usually assumed to increase with the growth of labour productivity in the progressive sector. Since the labour-productivity growth in the Baumol sector is slower than in the progressive industry, unit costs of the Baumol sector increases inevitably. This brings about higher inflation in the Baumol sector. This fact is known as Baumol’s cost disease (e.g. Baumol, 1993). In Baumol’s (1967, 417-18) model of unbalanced growth it is assumed that the economy consists of a progressive, A, and a Baumol sector, B. For simplicity we assume that both products are solely produced with labour (L_A and L_B respectively). The respective quantities of sector A and B can be written as follows:

$$Y(t)_A = a\, L(t)_A\, e^{rt} \qquad \text{with } t := \text{time and } r > 0. \qquad (4)$$

$$Y(t)_B = b\, L(t)_B\, e^{st} \qquad \text{with } s >= 0 \text{ and } r >> s. \qquad (5)$$

The labour-productivity growth of the progressive sector, r, outstrips productivity growth of the Baumol sector, s, by far. For simplicity, we assume that prices of both goods (p_A and p_B respectively) correspond to unit costs in the respective sector and that the nominal wage rate, w, is the same in both sectors. We assume that the wage rate increases with the productivity growth of the progressive sector, r.

$$p_A = w(t)\ L(t)_A/Y(t)_A = we^{rt}\ L(t)_A/a\ L(t)_A e^{rt} = w/a \tag{6}$$

$$p_B = w(t)\ L(t)_B/Y(t)_B = we^{rt}\ L(t)_B/b\ L(t)_B e^{st} = we^{(r-s)t}/b \qquad \text{with } r\text{-}s>0 \tag{7}$$

Equation (7) shows that the price level of the Baumol sector increases continuously, i.e. this sector suffers from the cost disease. In contrast, the price level of the progressive sector is stable (see equation (6)). Given that the total labour force, L, corresponds to the labour force engaged in the progressive and the Baumol sector of the economy, i.e. $L=L_A+L_B$, one can express total expenditure of each sector as follows:

$$p_A Y_A = w\ L(t)_A\ e^{rt} = w\ a\ L(t)\ e^{rt}/(1+\gamma(t)e^{(r-s)t}) \qquad \text{with } \gamma(t)=aY_B(t)/bY(t)_A \tag{8}$$

$$p_B Y_B = w\ L(t)_B\ e^{rt} = w\ b\ L(t)\ \gamma(t)e^{(2r-s)t}/(1+\gamma(t)e^{(r-s)t}) \tag{9}$$

Given that the employment ratio, $L(t)_B/L(t)_A$, remains constant over time, the value-added of both sectors grow proportionally to the productivity growth of the progressive sector, r (see equations (8) and (9)). While the value-added and the real output of the progressive sector increase at the same rate r, the value-added of the Baumol sector is primarily driven by the inflation rate, r-s, and only to a smaller extent by the growth rate of the real output growth, which equals s. Note that the employment ratio $L(t)_B/L(t)_A$ has to grow at a rate r-s to keep the output ratio between the Baumol sector and the progressive sector, $\gamma(t)$, constant as Baumol (1967) assumes.

In terms of total output of the economy total expenditure of the Baumol sector, e_B, can be expressed as follows:

$$e_B= p_B Y_B/(p_A Y_A + p_B Y_B) = L_B/L = 1/(1+1/(\gamma(t)e^{(r-s)t})) \tag{10}$$

The growth rate of employment in the stagnant sector, $\hat{L}_B$, over the employment growth in the progressive sector, $\hat{L}_A$, is represented by φ. Then, we can write down the real output ratio between the Baumol and the progressive sector as follows:

$$\gamma(t)=(L(t)_B/\ L(t)_A)e^{(s-r)t}=e^{(\varphi+s-r)t} \qquad \text{with } \varphi \in R \text{ and } L(0)_B/L(0)_A=1 \tag{11}$$

To simplify our analysis, we assume that the employment is evenly distributed between the two sectors in the starting period 0 (see equation (11)). Inserting equation (11) into equation (10) leads to the following equation:

$$e_B=\frac{1}{1+e^{-\varphi t}} \quad \wedge \quad \hat{e}_B=\frac{\varphi}{1+e^{\varphi t}} \text{ with } \hat{e}_B \coloneqq \text{growth rate of } e_B. \tag{12}$$

As the excess of the inflation rate in the Baumol sector over the progressive sector, r-s, compensates exactly for the excess of the productivity growth in the progressive sector over the Baumol sector, r-s, the expenditure share, e_B, depends only on the excess of the employment growth in the Baumol sector over the progressive sector, φ (see equation (12)). The expenditure share of the Baumol sector increases (decreases) if the employment in the Baumol sector grows faster (slower) than in the progressive sector. In the long run, the expenditure share of the Baumol sector and the output ratio between the Baumol sector and the progressive sector develop as follows:

$$\lim_{t\to\infty} e_B \to \begin{cases} 0 & if \quad \varphi<0 \\ \frac{1}{2} & if \quad \varphi=0 \\ 1 & if \quad \varphi>0 \end{cases} \quad \wedge \quad \lim_{t\to\infty} \gamma \to \begin{cases} 0 & if \quad \varphi<\mathrm{r}-\mathrm{s} \\ 1 & if \quad \varphi=\mathrm{r}-\mathrm{s} \\ \infty & if \quad \varphi>\mathrm{r}-\mathrm{s} \end{cases} \tag{13}$$

While the expenditure share of the Baumol sector in nominal GDP, e_B, only depends on the difference between the employment growth in the two sectors, φ, the output ratio (real terms), γ, is dependent on the relationship between the differences in productivity growth, r-s, and employment growth of the two sectors, φ (see equation (13)). Equation (13) shows that the expenditure share of the Baumol sector, e_B, approaches zero, if the employment growth in the Baumol sector is lower than in the stagnant sector, φ<0. The expenditure share of the Baumol sector remains constant, if the employment grows proportionally in both sectors, φ=0. If the

Baumol sector hires more worker than the progressive sector in every period, $\varphi>0$, the expenditure share of the Baumol sector would approach 1 in the long-run. However, stronger employment growth in the Baumol sector does not necessarily mean having a continuously shrinking output share of the progressive sector, γ (see equation (13)). As long as the excess of the employment growth of the Baumol sector lags behind or equals the excess of the productivity growth in the progressive sector, the output of the progressive sector either increases faster or at equal pace as the output of the Baumol sector. Only if the excess of the employment growth outstrips the excess of the productivity growth, the ratio of the output of the Baumol sector related to the output of the progressive sector becomes ever-larger in the long run. Baumol (1967) presupposes that $\varphi=r-s$ (Baumol case). As the higher productivity growth in the progressive sector outweighs the higher employment growth in the Baumol sector, the output ratio of the two sector remains constant over time. In contrast, the expenditure share of the Baumol sector in nominal GDP approaches 100% in the long run.

3.2. The fiscal impact of the cost disease

The considerations we have made so far allows us to analyse how the cost disease affects the ratio of the government expenditure to nominal GDP. It is well known that governments in developed countries play a major role in delivering personal services such as education, healthcare or the performing arts that Baumol (1993, 17-18) mentions as prime examples for the cost disease. To simplify our analysis we assume that the government transforms a part of privately produced goods into publicly provided goods. The government's share of the output of the progressive sector should amount to μ and the government's share of the Baumol sector should amount to λ. As the Baumol sector encompasses only services, the progressive sector comprises mainly the manufacturing industries and the government primarily provides personal services, we stipulate that the share of the government in the Baumol sector is considerably higher than in the progressive sector ($\lambda>>\mu$). Given these considerations, we can write down the ratio of government expenditure to nominal GDP, g_y, in Baumol's model of unbalanced growth as follows:[5]

$$g_y = \mu \underbrace{\frac{p_a Y_a}{pY}}_{=e_A} + \lambda \underbrace{\frac{p_b Y_b}{pY}}_{=e_B} = \mu + (\lambda - \mu) e_B = \mu + \frac{(\lambda-\mu)\mathrm{e}^{\varphi t}}{1+\mathrm{e}^{\varphi t}} \quad with \quad \begin{cases} 0 < \lambda \leq 1 \\ 0 \leq \mu \ll 1 \\ \lambda \gg \mu \end{cases} \tag{14}$$

While we allow for the prior assumption that the Baumol sector comprises only government services, λ=1, we do think that only a minor part of government activity such as infrastructure services can belong to the progressive sector, μ<<1. It may even be the case that government services do not belong to the progressive sector at all, μ=0. Equation (14) shows that the ratio of the total government expenditure to nominal GDP depends positively on the expenditure share of the Baumol sector to nominal GDP. Based on equations (12) and (14) we can derive the growth rate of government expenditure.

$$\hat{g}_y = (\lambda - \mu)\hat{e}_B = \frac{(\lambda-\mu)\varphi}{1+e^{\varphi t}} \begin{cases} > 0 \ \ if \ \ \varphi > 0 \\ = 0 \ if \ \ \varphi = 0 \\ < 0 \ \ if \ \ \varphi < 0 \end{cases} \tag{15}$$

Equation (15) shows that the growth rate of the public-expenditure-to-GDP ratio depends on the difference of the employment growth between the Baumol sector and the progressive sector, φ. Given that a larger part of government services is not produced progressively, the government can only stabilise the public-expenditure-to-GDP ratio if they manage to keep the employment growth in the public Baumol sector at the same pace as the employment growth in the progressive sector, i.e. φ=0 (see equations (14) and (15)). This implies that the public-expenditure-to-GDP ratio remains constant at 1/2*(λ+μ) (with e_B=1/2) and the government manages to adhere to a debt-brake rule (see equations (3), (13) and (15)).

$$g_y = \theta + \tau - iB = \mu + (\lambda - \mu)e_B = \frac{1}{2}(\lambda + \mu) \qquad if \ \ \varphi = 0 => \ e_B = \frac{1}{2} \tag{16}$$

[5] Note that we do not include government transfers in equation (14) as it would only complicate the theoretical analysis without a major change of our key results. Under the assumption that public transfers are not paid for the individual consumption of goods produced in the Baumol sector the government can tie transfers to nominal GDP in the long run. In contrast, if public transfers are paid for Baumol-sector goods this would be tantamount to a higher λ.

However, the fulfilment of the obligations of a debt-brake rule comes at a cost. As the productivity growth in the Baumol sector lags behind by (r-s)-percentage points, the output ratio between the Baumol sector and the progressive sector vanishes in the long term, γ->0 (see equation (13)).[6] As a consequence, both the real output of the Baumol sector, Y_B, and the real output of the public Baumol sector, $\lambda * Y_B$, shrink steadily. Nevertheless, the above-average inflation rate of the Baumol sector, r-s, outweighs the reduction of the quantity of cost-disease-affected government services. As a result, the public-expenditure share of cost-disease affected government services, λe_B, remains constant. If the government adheres to a debt-brake rule, the quantity of cost-disease-affected government services shrinks inevitably.

If we turn to the Baumol case, i.e. φ=r-s, the ratio of public expenditure to GDP increases steadily (see equation (15)). Only if the expenditure share of the Baumol sector, e_B, approaches one in the long run, the public-expenditure-to-GDP converges to the government share of the Baumol sector, λ (see equations (13) and (17)).

$$\lim_{t\to\infty} g_y \to \mu + (\lambda - \mu)e_B = \lambda \quad <= \quad \lim_{t\to\infty} e_B \to 1 \ with \ \varphi = r - s \tag{17}$$

Thus, the government can stabilise the public-expenditure-to-GDP ratio if the nominal GDP corresponds to the value-added of the Baumol sector. Under this scenario progressive government activities are completely crowded out by the cost-disease affected government services. Equation (17) implies that the employment share of the Baumol sector is equal to 100% (see equation (10)). Even if the whole service sector was affected by the cost disease, the employment share of the Baumol sector in developed countries would be still well-below 100% (Colombier, 2017). Therefore, the case depicted in equation (17) can be deemed as highly unrealistic. If we exclude this special case from our considerations, the government can only keep the quantity of the public Baumol sector constant with respect to real GDP, i.e. φ=r-s, if the public-expenditure-to-GDP ratio is allowed to rise. This means breaching the balanced-

[6] Note that a shrinking γ means having also a declining share of the Baumol-sector output in total output as $Y_B/Y= b\gamma/(a+ b\gamma)$ with $d(Y_B/Y)/d\gamma>0$.

budget rule. To sum up, under a debt-brake rule the government risks that the public Baumol sector vanishes in real terms.

The government has only a few options to prevent this outcome in the long term. First, the government may opt for reducing the share of the cost-disease affected government services so that the composition of the progressive and the stagnant parts of the government and the whole economy coincides, i.e. λ-μ=0 and dλ<0. As a result, the productivity growth and the inflation rate of the government sector match the overall productivity growth and the inflation rate. In this case, the government can increase the quantity of the public Baumol sector in line with the quantity growth of the progressive sector, i.e. φ=r-s, without breaching the balanced-budget rule (see equations (14) and (15)). This strategy implies that the cost-disease-prone government expenditure are crowded out by the other government expenditure ('budget crowding out'). However, this option is highly unrealistic as the government usually steps in if the markets fail, distribute unevenly or are volatile. In addition, this option is politically unfeasible if cost-disease prone public services meet basic needs of the citizens such as healthcare or citizens attach a high value to these services.[7] The option to reduce the share of government services caught by the cost disease may be even technically unfeasible if these services amount to a large proportion of total government expenditure.[8] Second, the government might try to bring about leaps in productivity of the public services contracted by the cost disease. However, the productivity-growth difference between the progressive and the Baumol sector has to shrink to zero, i.e. φ=0 as r-s=0, if the government obeys the debt-brake rule. Since the cost disease is rooted in the personal-intensive production technology, however, this task seems to be insurmountable. A final option for the government might be to curb the wage growth of civil servants to the productivity growth of the stagnant sector, i.e. $\hat{w}_{gov} = s$. As a result, the excess

[7] Nevertheless, Chen and Moul (2014) provide evidence that the cost disease has led to shrinking teacher-pupil ratios in the public education sector of the US states from 1997 to 2010. Chen and Moul (2014), however, do not refer to the interplay between the cost disease and fiscal rules.

[8] In contrast, the government may be able to cut cost-disease affected public services temporarily (see Ryan, 1992, 277).

of the inflation rate in the Baumol sector in equation (10) is not equal to r-s, but to s-s and, thus, equal to zero for the public part of the Baumol sector, $\lambda p_B Y_B$. The excess inflation of the public sector over the general economy is eliminated. In this case φ is exactly compensated by the productivity-growth difference between the progressive and the Baumol sector, r-s and, therefore, equivalent to $\varphi=0$ (see equations (10) and (14)). However, this strategy may cause labour-shortages in the public services in the long run. In addition the government might not be able to recruit sufficiently qualified personnel, which can be detrimental to the quality of personal-intensive public services.

So far we have assumed that the government has recognised that Baumol's cost disease affects the public sector. If the government does not notice Baumol's cost disease, as Chen and Moul (2014, 223) assume for the US states, but wants to adhere to the debt-brake rule, the personal-intensive public services may crowd out other government services such as public infrastructure services, i.e. $d\mu<0$. Nonetheless, this can only be a temporary measure as μ approaches zero after a while and the cost-disease-affected government expenditure grow continuously faster than nominal GDP if $\varphi=r-s>0$ (see equations (14) and (15)). Under a debt-brake rule, the government is coerced to stabilise the expenditure share of the public Baumol sector to GDP in the long run. As a result, φ should be zero in the longer run and real government output has to decline continuously except for the unrealistic case that nominal GDP comprises only the value-added of the Baumol sector.

In addition, if some government expenditure items are productive, adhering to a debt-brake rule would mean foregoing growth opportunities for the following reason. A well-known hypothesis of endogenous growth theory is that the ratio of productive public expenditure to GDP in real terms promotes the steady-state growth rate of an economy (see e.g. Colombier, 2009, 901). Empirical evidence confirms this hypothesis and shows that public expenditure items such as those on infrastructure and education are growth-enhancing (see Colombier, 2009, 909). Thus, the application of a debt-brake rule bears the risk of slowing-down economic growth.

These results suggest that a balanced-budget rule can have detrimental effect on the provision of public services if the latter are affected by the cost disease. The government face a serious dilemma. Either the government risks reputational losses if they breach the debt-brake rule or the government risks a budget-crowding-out of the quantity of cost-disease affected government services or a budget-crowding-out of other government services. In addition, the government might risk a quality reduction of government services and may miss out growth-opportunities if they obey the debt-brake rule. In the following we show that the Baumol's cost disease has a bearing on the public sector. Before we turn to our empirical findings we set out the econometric method.

4. Method and data

The empirical analysis is based on a sample of 24 OECD countries and the time spans from 1990 to 2010 (see Appendix). To test the impact of Baumol’s cost disease on the government sector we apply a new method developed by Hartwig (2008) and Colombier (2017), the Baumol variable. The Baumol variable offers the advantage to avoid the usage of output measures or price indexes of the service sector, which are notoriously difficult to measure (e.g. Griliches, 1992). In this present analysis we resort to the general case of the Baumol variable, the so-called adjusted Baumol variable (Colombier, 2017). The adjusted Baumol variable corresponds to the difference between the economy-wide average growth rate of wages and the labour productivity growth rate in real terms divided by the employment share of the sector possibly contracted by the Baumol’s cost disease (Colombier, 2017). As a result, a circularity enters as we have to define the size of the Baumol sector in advance. However, as only the service sector is commonly viewed as susceptible to Baumol’s cost disease (Schettkat and Yocarini, 2006), we know the maximum possible size of the Baumol sector. Therefore, we adjust the Baumol variable by the employment share of the whole service industry. In addition, we carry out a sensitivity analysis by using an alternative definition of the Baumol sector. Baumol (1993, 17) holds the view that, in particular, the personal services such as education or healthcare are affected by the cost disease. Therefore, we use the employment share of community, personal and social services as an alternative to construct the adjusted Baumol variable.

To test the relevance of Baumol's cost disease for government services we use per-capita public expenditure in real terms as the dependent variable. The latter serves as a proxy for unit costs of government services. Since we are interested in analysing how Baumol's cost disease affects different areas of government activity we use government expenditure decomposed by function according to the COFOG classification as dependent variables. [9] As a Baumol sector is characterised by a labour-intensive production process, we exclude government expenditure on infrastructure, i.e. the functions economic affairs and housing and community affairs and defence from our analysis. We focus on public expenditure on general public services, education, healthcare, social security, public order and safety, and recreation, culture and religion.

We control for further possible economic determinants of public expenditure. First of all, real GDP per capita is included in our estimations as a proxy for Wagner's law. Apart from Baumol's cost disease Wagner's law is considered as a prime explanation for an expansion of the public sector (e.g. Neck and Getzner, 2007). In contrast to Baumol's cost disease Wagner's law is a demand-side explanation of an expanding government sector. Empirically, Wagner's law is confirmed if the income elasticity of demand for government services is above one, i.e. publicly provided goods are luxury goods.[10] Moreover, the unemployment rate is included as a socio-economic indicator. Not only can a higher unemployment rate lead to higher social

[9] For a detailed description of public expenditure categories, see Classifications of the Functions of Government (COFOG), United Nations Statistics Division.

[10] Wagner's law can be viewed as a special case of the demand-side explanation for the expansion of the whole service sector in the economy. Note that with a rising share of the services industries in GDP the importance of Wagner's law diminishes. For an overview of explanations for an expansion of the service industries see Schettkat and Yocarini (2006).

transfers such as unemployment benefits, but can also affect public expenditure on healthcare (Brändle and Colombier, 2016; Bose, 2015). Several studies show that political-economy factors affect public expenditure (e.g., Potrafke, 2009; Cox and McCubbins, 2001; Persson and Tabellini 2000). Therefore, we take a few core political-economy explanations of increasing public expenditure, the partisan hypothesis, electoral business cycles and electoral rules, into account. The political-economy determinants are represented by dummy variables for the government ideology, i.e. right-wing, left-wing and centrist, and the electoral system, i.e. a plurality versus a proportional rule, and electoral years in our estimations. According to the partisan hypothesis, left-wing governments care more about distribution and therefore, favour higher government expenditure, in particular social welfare expenditure. Due to re-electoral motives the government might spend more at the end of the term in office than during their first years in office. Compared to a plurality rule, allocating parliamentary seats proportionally to the votes (proportional rule) raises the risk for a multi-party coalition. The latter is susceptible to a fragmentation of government, which is a common-pool problem. Thus, a multi-party coalition increases the likelihood of pork-barrel decisions and horse-trading, which drives up public expenditure.

A commonly held view is that demography has a considerable bearing on public expenditures, in particular, on old-age pensions, healthcare, long-term care and education (e.g. European Commission, 2015). Thus, we include proxies for the demographic development. We use the youth-dependency ratio, i.e. the ratio of the up to 15-years old to the whole population, and the old-age-dependency ratio, i.e. the number of the above 64-years old to the whole population, in our regressions.

The stochastic equation of the per-capita public expenditure item, g_j, which is applied in real terms, can be written as follows:[11]

[11] We are aware of the fact that using the same model for all functions of governments can only be viewed as a first approximation to test for Baumol's disease. However, an in-depth account of the possible determinants for

$$\Delta g_{j,i}(t) = \underbrace{\alpha_j \frac{1}{l(t)_{B,i}} (\hat{w}_i(t) - \hat{\mu}_i(t))}_{\text{adjusted Baumol variable}} + \sum_{n=1}^{5} \beta_{j,n} \Delta z_{i,n}(t) + \sum_{l=1}^{2} \delta_{j,l} d_{i,l}(t) + \sigma_i + \lambda(t) + u_{j,i}(t) \quad (18)$$

whereby j represents government expenditure item j, i represents country i, i:= 1,...,23; t represents year t, t:= 1990,...,2010, $u_{j,i}(t)$ represent the residuals of the regression and α_j, $\beta_{j,n}$ and $\delta_{j,l}$ stand for the regression coefficients of the adjusted Baumol variable the n-th continuous control variable ($\Delta z_{j,n}$) such as the real GDP per capita, the old-age dependency ratio or election years, and the dummy variables for government ideology and electoral rules. (d). Note that if the coefficient of the adjusted Baumol variable, α_j, is equal to one, government service j is fully contracted by Baumol's cost disease. If α_j corresponds to zero, government service j does not suffer from the cost disease. Except for the adjusted Baumol variable and the dummy variables all variables are expressed in natural logarithms and in first differences (Δ) in order to deal with non-stationarity and auto-correlation (see Appendix, Table A1). To estimate equation (13) we apply a two-way fixed effects approach with unobserved country- (σ_i) and time-fixed ($\lambda(t)$) effects. In addition, we use Hartung's (1999) combining p-test to apply the Ljung-Box test on auto-correlation and the Shapiro-Wilk test on normality to a panel data set.

Panel data sets include usually several outliers due to heterogeneity and diversity across countries and times (see Aquaro and Cizek, 2013, 536). The standard fixed-effects estimators that are based on LSE are very sensitive to outlying observations. Outliers that generate a heavy-tailed statistical distribution can seriously harm the LSE These outliers include bad leverages that are both outlying in the space of the explanatory variables and the dependent variable and vertical outliers that are outlying in the y-dimension. Typical examples for such harmful outliers are measurement and transcription errors, uncommon events such as an oil crisis, and model failures such as the omission of relevant variables. However, not all outliers are detrimental for LSE. Good leverages that are outliers in the space of the explanatory variables raise the

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each of the government functions goes beyond the scope of this study because our concern is to examine whether there is any evidence for Baumol's cost disease across the whole spectrum of government activities.

precision of the regression. In contrast, a crucial indicator for the sensitivity of an estimator to outliers is the breakdown point. This indicator provides the maximal fraction of outliers an estimator can withstand. In other words: the estimator "breaks down" when it fails to adequately represent the pattern of the majority of the data (see Aquaro and Cizek, 2013, 537). Only a single outlier can severely bias the within group fixed effects LSE, which implies that the breakdown point of the fixed effects LSE converges to zero asymptotically (see Aquaro and Cizek, 2013, 537). Harmful outliers can also lead to a substantial loss of the efficiency of the LSE, approximately between 10% and 100%. (see Hampel, 2000, 19). In order to reduce the sensitivity to outlying observations substantially and achieve high efficiency, we apply the robust MM estimator proposed by Yohai et al. (1991). This estimator is a so-called high-breakdown estimator, which reconciles outlier-robustness and a high efficiency. Since the robust MM-estimator identifies the most coherent part of the underlying sample, the drawback of parameter heterogeneity of panel-data regressions can also be mitigated. To deal with heteroscedasticity of the residuals the heteroscedasticity-consistent and outlier-robust covariance estimator proposed by Cribari-Neto and Da Silva (2011) (HC4m) is applied. Furthermore, we use an innovative approach proposed by Marivana (2012) to test if the LSE was biased and inefficient or inefficient.

4. Results

4.1 Biased and inefficient LSE

In order to examine whether LSE are biased and inefficient, we draw a comparison between regressions with different estimators for two selected government expenditure items, total government and health. We run regressions using a least-squares-dummy-variable estimator (LSDV) and an MM estimator with outliers and LSDV without outliers (see Table 1). We exclude vertical outliers and bad leverages from the LSDV regressions

*** Insert Table 1 about here ***

Our analysis provides several indications that the LSDV estimator is biased and inefficient. The bias and inefficiency test suggests that the LSDV estimator is either biased and inefficient or inefficient. Not only do the LSDV estimates of the adjusted Baumol variable sizeably differ from the MM estimates but the LSDV coefficients are statistically insignificant precisely when the MM coefficients are statistically significant. If outliers are excluded from the LSDV regressions the bias and inefficiency test cannot reject the hypothesis that the LSDV estimator is an unbiased and efficient estimator and the differences to the MM regressions almost vanish. Corresponding to these findings, the bias-and-efficiency test in Tables 2 and 3 show that the LSDV estimator with outliers would be biased or inefficient. Overall, these results suggests a considerable downward bias of the LSDV estimator with respect to the coefficient of the adjusted Baumol variable. These findings demonstrate the benefits of using an outlier-robust estimation method.

4.2. Level and composition of public expenditure

Before we report on the regression results, a few descriptive statistics are presented. In Figure 1, the development of the ratio of total government expenditure to GDP is shown for all countries in the sample from 1990 to 2010.

*** Insert Figure 1 about here ***

What is striking is that in almost all of the countries the public-expenditure ratio has been either stable or even has been diminished. The exceptions are the United Kingdom and Portugal. In addition, we can observe that the public-expenditure ratio surpasses pre-crisis levels only after the financial crisis and the Great Recession in some countries. Overall, Figure 1 suggests that an implementation of the balanced-budget rule would not appear to be necessary to stabilise the public-expenditure-to-GDP ratio.[12] One cannot infer from Figure 1 that forces such as Baumol's cost disease, Wagner's law or public-choice-related factors have driven up

[12] Note to assess whether an implementation of a balanced-budget rule is pertinent, the development of the public-debt-to-GDP ratio has to be considered as well.

government expenditure in terms of GDP. Nonetheless, the development of the public-expenditure ratios shown in Figure 1 does not exclude the possibility that Baumol's cost disease causes a reduction in the quantity of government services under fiscal restraints.

*** Insert Figure 2 about here ***

In dependence of the weight of the respective government services, the fiscal impact of the cost disease can be more or less strong. The outlays on social security consume by far the highest share of government expenditure followed by general administration, health and education (see Figure 2). Consequently, the leeway of government shrinks if these fiscally important government expenditure items are affected by the cost disease

4.3 Baumol's cost disease and further determinants of public expenditures

We test two different model specifications. In model *a* we include only economic and demographic drivers, which might affect government expenditures (see Table 2). In model *b* we add political- economy determinants. The findings with respect to the impact of Baumol's cost disease do not differ much between these specifications. This is due to the fact that political-economy determinants would not appear to explain much of the variation of the public expenditure items. However, there might be confounding effects with country- and time-fixed effects. Our findings suggests that Baumol's cost disease affect the government sector. Independently from the model specification the coefficient of the adjusted Baumol variable is highly statistically significant and is estimated to be slightly below 0.1 for total government expenditure (see Table 2).

*** Insert Table 2 about here ***

In accordance with expectations, our analysis provide evidence that the government sectors healthcare, education and recreation, culture and religion are affected by the cost disease. The strongest impact of the cost disease seems to be in healthcare, which is in line with recent evidence (Hartwig, 2008; Colombier, 2017). In contrast, our results suggests that the government sectors general administration, public order and safety, environment protection and social security are not affected by the cost disease, which is counter-intuitive in some cases. However, the government function general administration covers a broad range of tasks. Not only does this function comprise administrative services for the parliament, fiscal and external affairs, but also public-debt transactions and non-earmarked transfers between the central, regional and municipal government levels. Public-debt transactions and government transfers are certainly not prone to the cost disease, which provides a plausible explanation for our result. However, we cannot convincingly explain why government services on public order and safety would not suffer from the cost disease as our findings indicate. The provision of police and juridical services epitomises a Baumol sector as these are personal services and the productivity growth should be close to zero. Nonetheless, the positive statistically correlation between the real GDP per capita and government expenditure on public order and safety suggests that richer societies demand a higher standard of police and juridical services. According to our results, only the demand-side drives this public expenditure item and the cost-disease's impact is negligible. Environmental protection contains policy measures such as waste management or pollution abatement, e.g. the construction of noise embankments. Therefore, our result that the cost disease does not affect public expenditure on environmental protection seems to be plausible. Since a large part of social protection consists of redistributive measures, i.e. social transfers, our finding concerning public spending on social security seems to be reasonable.

We find a close correlation between real GDP per capita and total government expenditure. In addition, our findings indicate that all but one government function, general administration, are closely correlated with real GDP per capita. Thus, as societies become richer more government services are demanded, but in a less than proportional manner. All coefficients of GDP per capita are below one. This suggests that Wagner's law is not valid. However, if we refer to a 95%-confidence interval, we cannot reject Wagner's law for public expenditure on healthcare, environmental protection and recreation, culture and religion.

As is expected, the unemployment rate exerts a positive impact on social-security expenditure. The correlation is highly statistically significant. Furthermore, the unemployment rate has a positive statistically significant correlation with public expenditure on general administration. Given that the government function general administration includes public-debt transactions and transfers within the government sector, this result seems to be plausible. A rising unemployment rate causes an increase of government expenditure, for example for the unemployed. As a result, the public debt and transfers between different levels of government such as those on loans to the unemployment insurance may rise also. Only for healthcare we find a statistically significant correlation with the demographic variables.

4.4 Sensitivity analysis: an alternative definition of the Baumol sector

As is mentioned in section 3, we have to define the extent of the Baumol sector a priori in order to test for Baumol's cost disease. To show how the estimations are affected by using an alternative definition of the Baumol sector we adjust the Baumol variable by the inverse of the employment share of the community, personal and social services. In contrast to total services the business sector services are excluded.

*** Insert Table 3 about here ***

The estimations including an alternative adjusted Baumol variable confirm the findings of the basic estimations. Corresponding to the basic estimations in Table 2, Table 3 indicates that the total government sector and the government functions of health care, education, and recreation, culture and religion are affected by Baumol's cost disease. As one can expect, the estimates are systematically smaller than in the basic estimations (see Tables 2 and 3). The a priori determination of the Baumol sector raises the uncertainty about the extent of the cost disease. For instance, the coefficient of the adjusted Baumol variable for total government expenditure ranges between 0.03 and 0.09 (see Tables 2 and 3). This applies also to the other government functions affected by the cost disease.

Baumol's model of unbalanced growth predicts that a rising output share of the Baumol sector slows down overall productivity and GDP growth. Thus, the adjusted Baumol-variable may suffer from an endogeneity bias. Therefore, we have also carried out instrumental variable regressions. However, it is elusive to find a suitable instrument for the adjusted Baumol variable. We select the Baumol variable lagged by one year and, following Colombier (2017), the productivity growth in the manufacturing industry as instruments. However, the F tests does not suggest that the IV of the adjusted Baumol variable are very strong (see Appendix, Table A2). Consequently, one should interpret the results of the instrumented regressions with caution. Therefore, we report the results of the instrumented regressions only in the Appendix (see Table A2). Nevertheless, the instrumented regressions indicate that the basic estimates of the adjusted Baumol variable seem to be downward biased. The results are confirmed with respect to total government expenditure and healthcare, but not for education and recreation, religion and culture. Furthermore, the IV regressions suggest a positive statistically significant coefficient of the adjusted Baumol variable in the case of public order and safety and social security.

5. Conclusion

This present papers shows that a balanced-budget rule is not consistent with Baumol's cost disease. If government services suffer from Baumol's cost disease the application of a balanced budget rule would lead to a reduction in the quantity of disease-contracted government services or a budget-crowding of non-contracted government services. As a result, governments face a serious dilemma between involuntarily reducing government services by adhering to the balanced-budget rule and putting fiscal sustainability at risk by breaching the rule. The empirical analysis shows that the government sector suffers partly from the cost disease. In particular, public spending on healthcare and education are contracted by the cost disease, though only in parts. Many studies suggest that public healthcare and educational expenditure can be productive (e.g. Colombier, 2011; Suhrke et al., 2006). Consequently, a cut of these government expenditures may cause adverse consequences for economic growth. Based on the findings of this present paper we reach the conclusion that the EU is well advised to fine-tune the fiscal compact in order not to cut unintentionally productive public expenditure items due to Baumol's cost disease. Policy-makers should be aware of the fact that the application of a balanced budget rule without making a difference between productive and non-productive government expenditure can be growth retarding. In addition, the quality of government services contracted by the cost disease suffers in all likelihood under a balanced budget rule in the long term if governments fail to provide a solution to the above-mentioned dilemma.

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Appendix

Data

The sample consists of 24 OECD countries, which include Austria, Belgium, Canada, Switzerland, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Japan, Korea, Netherlands, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom and United States, and range from 1990 to 2010. The data originate from the OECD statistics and the AMECO database of the European Commission. Moreover, we use data from the Swiss government finance statistics. For the estimations we apply the open-source statistical software R.

Tables Appendix

Table A1: Modified-Choi-panel-ADF unit root test

Variable		Modified-Panel-ADF test
Total	Level	0.2 (0.6)
	First differences	-7*** (0.0)
Healthcare	Level	0.6 (0.7)
	First Differences	-6*** (0.0)
Education	Level	1.0 (0.9)
	First Differences	-2** (0.04)
General government	Level	0.5 (0.7)
	First Differences	-5*** (0.0)
Public order & safety	Level	1 (0.9)
	First Differences	-5*** (0.0)
Environment protection	Level	-0.3 (0.4)
	First Differences	-8*** (0.0)
Recreation, culture & religion	Level	2 (1.0)
	First Differences	-5*** (0.0)
Social security	Level	0.7 (0.8)
	First Differences	-5*** (0.0)
Real GDP per capita	Level	5 (1.0)
	First Differences	-4*** (0.0)
Youth dependency ratio	Level	2 (0.9)
(until 15 to all ages)	First Differences	4 (1)
	Second Differences	-4.5*** (0.0)
Old-age dependency ratio	Level	7 (1)
(above 64 to all ages)	First Differences	0.6 (0.7)
	Second Differences	-7.3*** (0.0)
Adjusted Baumol variable		
Total Services	Level	-1.6* (0.06)
Community, social & personal services	Level	-2.1** (0.02)

Notes: Modified-Choi-panel-ADF unit root test takes cross-sectional dependence into account, H0: panel data series contains a unit root; t test statistic, p-value in parentheses. Tests are run with an individual intercept and a deterministic trend. Given the rather short time series (at maximum: 21 observations), the number of lags is set equal to one.

***:= 1% significance level; **:= 5% significance level; *:= 10% significance level.

Table A2: The impact of Baumol's cost disease on government expenditure – instrumented regressions

	Dependent variable: public expenditure by function					
	Total		Health	Education	General administration	Public order & safety
	I	II				
Adjusted Baumol variable	0.07 (0.25)	0.09* (0.05)	0.44** (0.12)	0.15 (0.12)	-0.18 (0.16)	0.29* (0.16)
Outlier-robust HC SE[a]	*(0.58)*	*(0.07)*	*(0.17)***	*(0.14)*	*(0.21)*	*(0.21)*
Real GDP per capita	0.78 (0.67)	0.70** (0.31)	1.97** (0.43)	0.96** (0.48)	0.03 (0.96)	0.03 (0.70)
Unemployment rate	0.03 (0.08)	0.03 (0.03)	0.01 (0.06)	-0.01 (0.05)	-0.14 (0.11)	-0.003 (0.007)
Youth dependency ratio (until 15 to all ages)	-0.16 (0.26)	-0.40 (0.22)	0.57* (0.30)	0.28 (0.24)	-1.11** (0.55)	0.17 (0.34)
Old-age dependency ratio (above 64 to all ages)	-0.09 (0.26)	0.005 (0.19)	0.44** (0.21)	0.36** (0.14)	0.21 (0.29)	0.31 (0.34)
Adjusted R squared	6.5	3.1	-0.02	-0.2	-0.1	-0.05
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	288	296	288	288	288	288
No. of countries	23	24	24	24	24	24
Stock & Watson's rule-of-thump						
Adjusted Baumol	7.3	11	9.8	9.7	9.7	9.7
GDP per capita	37	35	31	31	31	31
Unemployment rate	9.3	9.6	9.1	9.2	9.2	9.2
Sargan's overidentification test	0.1	-2.1	-0.4	-5.7	63***	-1.1
Breusch-Pagan test	91***	87***	35	90***	132***	87***
Panel Ljung-Box test	1.3	2.6*	1.4*	-0.02	0.5*	-0.3**

Instruments: The adjusted Baumol variable (total services) is instrumented by the Baumol variable lagged by 1 year except for model I. In model I the adjusted Baumol variable is instrumented by the productivity growth of the manufacturing industry. GDP per capita is instrumented by GDP per capita lagged by 1 year; the unemployment rate is instrumented by the unemployment rate lagged by 2 years. The lag-length selection is based on the AIC criterion.

Notes: Dependent variable and per capita GDP are in first differences of logs. 2-way fixed effects (FE) estimation with the statistically robust MM estimator. As the Ljung-Box test indicates serial correlations we use a heteroskedasticity-autocorrelation consistent covariance estimator (HAC), albeit it is not outlier-robust. The outlier-robust HC consistent standard errors seem to be inefficient due to serial correlation (see HC SE of the adjusted Baumol variable provided in italics). t tests: figures in parentheses are HAC-consistent SE.

Stock & Watson's rule-of-thump: F test statistic ≥10, values in italics indicate that instruments are relevant; Sargan's overidentification test: H0: all instruments are valid; SARG test statistic.

***:= 1% significance level; **:= 5% significance level; *:= 10% significance level.

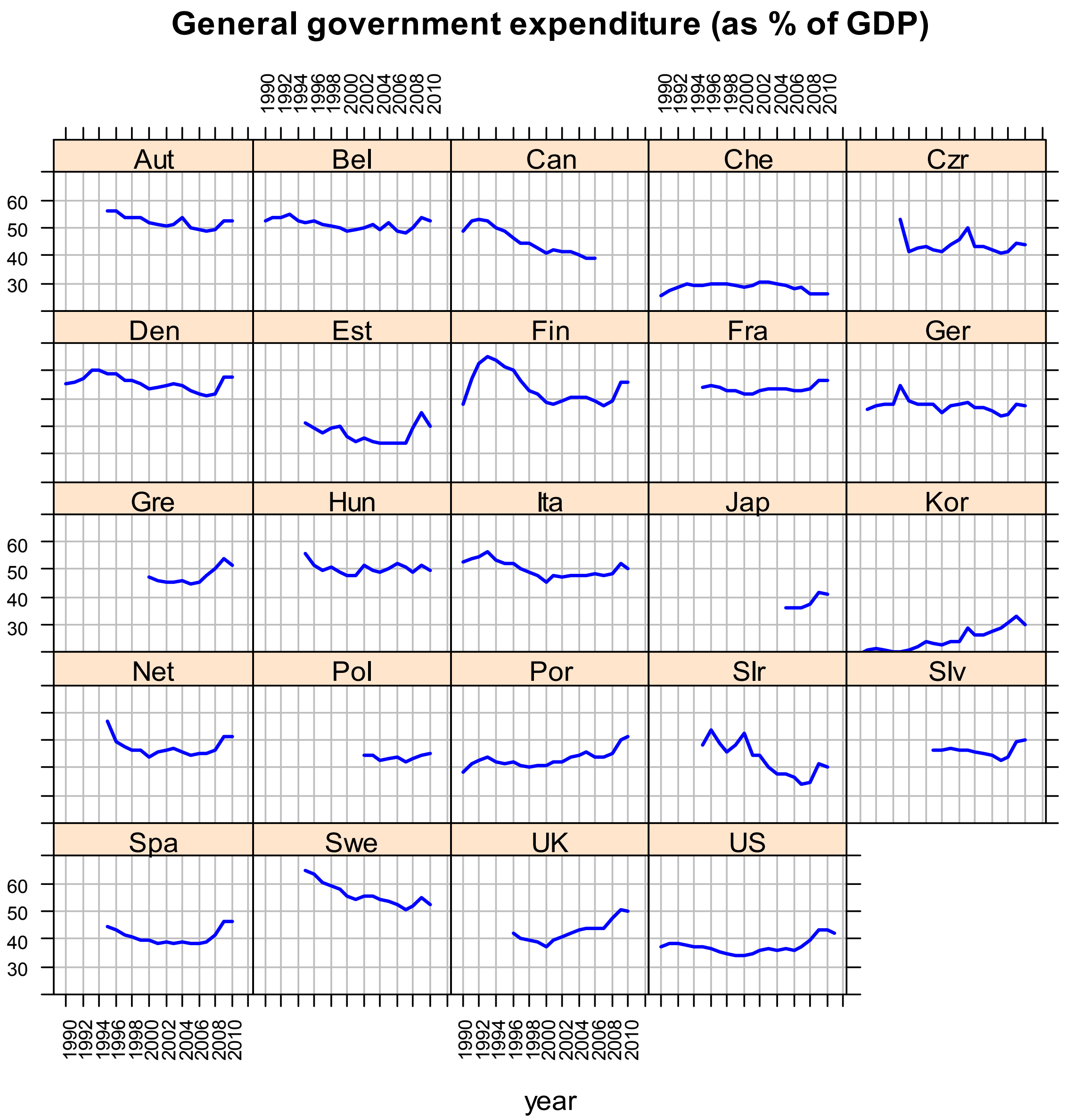
[a] The outlier-robust HC standard errors shown for the adjusted Baumol variable illustrate that the HC SE seem to be biased upwards due to serial correlation. Stars next to the parentheses in italics indicate that based on HC SE the coefficient of the adjusted Baumol variable is statistically significant.

Table A2 *continued*

	Dependent variable: public expenditure by function		
	Environment protection	Recreation, culture & religion	Social security
Adjusted Baumol variable	0.46 (0.33)	0.21 (0.23)	0.18** (0.07)
Outlier-robust HC SE[a]	*(0.49)*	*(0.32)*	*(0.11)**
Real GDP per capita	6.27*** (1.56)	1.36 (1.17)	1.46*** (0.47)
Unemployment rate	0.42*** (0.16)	-0.21** (0.08)	0.25*** (0.04)
Youth dependency ratio (until 15 to all ages)	-0.07 (0.92)	-0.76 (0.49)	-0.10 (0.24)
Old-age dependency ratio (above 64 to all ages)	-0.93 (0.59)	0.14 (0.31)	-0.17 (0.13)
Adjusted R squared	-0.2	-0.3	7.5
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
No. of obs.	270	288	296
No. of countries	23	24	24
Stock & Watson's rule-of-thump			
Adjusted Baumol	10	9.7	10
GDP per capita	30	31	30
Unemployment rate	9.1	9.1	9.5
Sargan's overidentification test	-0.2	-33	-23
Breusch-Pagan test	47	59*	57
Panel Ljung-Box test	2.5*	3.1*	-1.8*

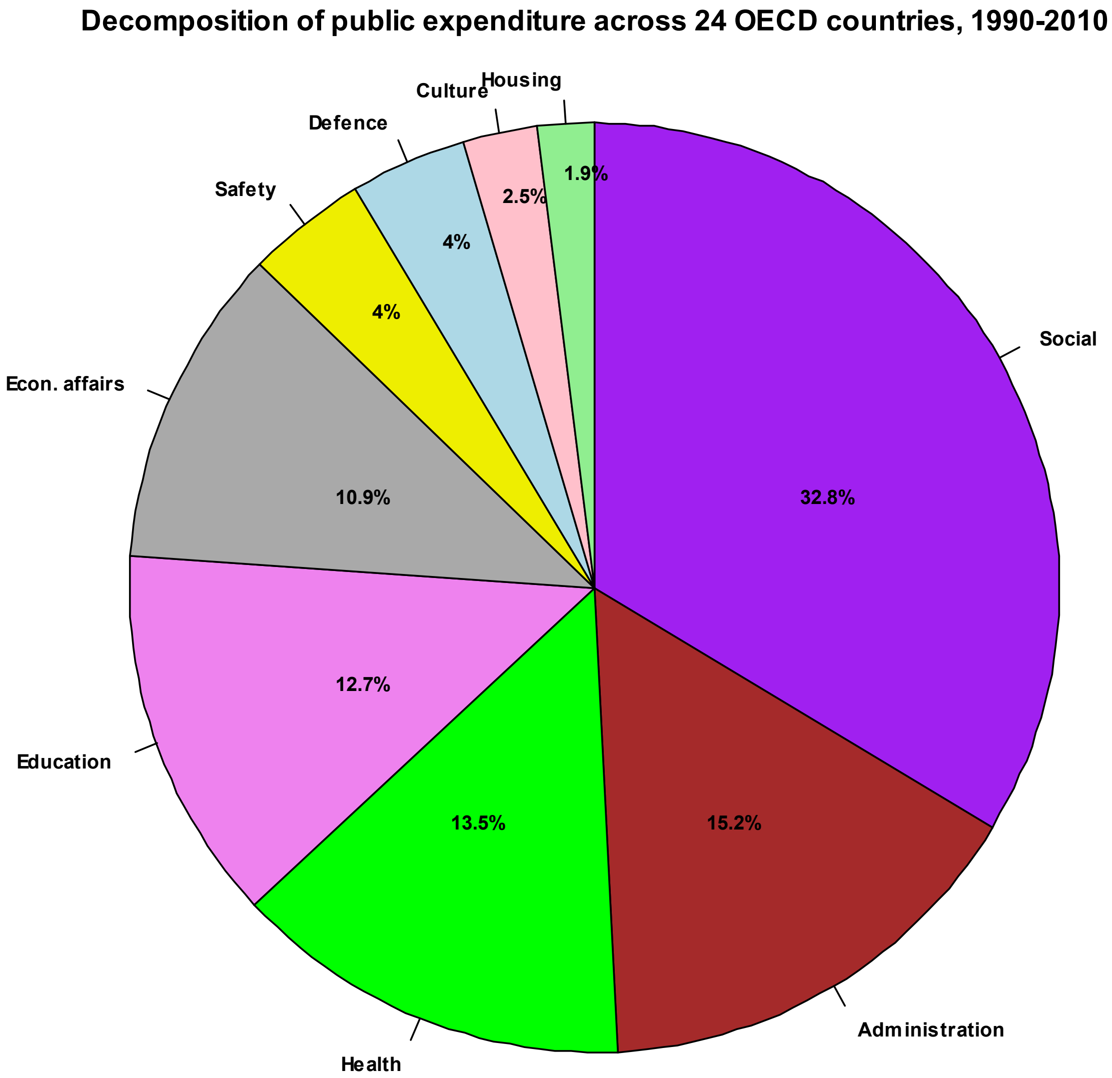
Figures

Figure 1



Source: OECD.

Figure 2



Source: OECD and Swiss Government Finance Statistics.

Tables

Table 1: Comparing the effect of outliers on OLS and MM estimates

	Dependent variable: public expenditure by function					
	Total			Health		
Estimator	OLS	MM	OLS	OLS	MM	OLS
Outliers included	yes	yes	no	yes	yes	no
Adjusted Baumolvariable	0.04 (0.05)	0.07** (0.03)	0.07** (0.03)	0.08 (0.10)	0.16*** (0.05)	0.12** (0.05)
Real per capita GDP	0.32* (0.18)	0.53*** (0.11)	0.46*** (0.12)	0.82** (0.35)	0.92*** (0.16)	0.90*** (0.18)
Unemployment rate	0.002 (0.02)	0.02 (0.01)	0.01 (0.01)	-0.004 (0.04)	0.005 (0.02)	0.007 (0.02)
Youth dependency ratio (until 15 to all ages)	0.18 (0.35)	-0.17 (0.20)	-0.20 (0.21)	1.37** (0.63)	0.84** (0.30)	0.93*** (0.33)
Old-age dependency ratio (above 64 to all ages)	-0.02 (0.24)	0.003 (0.14)	-0.07 (0.14)	0.39 (0.43)	0.40** (0.20)	0.24 (0.22)
Adjusted R squared	16	24	42	8.9	13	30
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	314	314	299	304	304	297
No. of countries	24	24	24	24	24	24
Bias & inefficiency test LSDV	251***	-	2.98	182***	-	4.86

Notes: Dependent variable and per capita GDP are in first differences of logs. 2-way fixed effects (FE) estimation with the statistically robust MM estimator and LSDV estimator using an outlier-robust covariance estimator proposed by Cribari-Neto, Da Silva (2011) that corrects for heteroskedasticity. t tests: figures in parentheses are robust SE. Two types of outliers are excluded: vertical outliers and bad leverages; t tests: figures in parentheses are robust SE; Bias & inefficiency test (Maravina, 2012; T1 test), H0: Gaussian distribution; rejection of H0 means OLS is inefficient or inefficient and biased, chi-squared test statistic.

***:= 1% significance level; **:= 5% significance level; *:= 10% significance level.

Table 2: The impact of Baumol's cost disease on government expenditure – basic estimations

	Dependent variable: public expenditure by function					
	Total		Health		Education	
Model	a	b	a	b	a	b
Adjusted Baumolvariable[a]	0.07** (0.03)	0.09*** (0.03)	0.16*** (0.05)	0.16*** (0.05)	0.09** (0.04)	0.10** (0.04)
Real per capita GDP	0.53*** (0.11)	0.49*** (0.11)	0.92*** (0.16)	0.89*** (0.17)	0.68*** (0.15)	0.64*** (0.15)
Unemployment rate	0.02 (0.01)	0.01 (0.01)	0.005 (0.02)	0.003 (0.02)	-0.006 (0.02)	-0.006 (0.02)
Youth dependency ratio (until 15 to all ages)	-0.17 (0.20)	-0.07 (0.21)	0.84** (0.30)	0.87*** (0.31)	0.21 (0.27)	0.25 (0.28)
Old-age dependency ratio (above 64 to all ages)	0.003 (0.14)	0.03 (0.14)	0.40** (0.20)	0.39*** (0.21)	0.21 (0.18)	0.23 (0.19)
Government ideology						
Center vs left		0.004 (0.006)		0.003 (0.01)		-0.002 (0.01)
Right vs left		-0.003 (0.003)		-0.005 (0.005)		-0.006 (0.005)
Election years		0.004 (0.003)		0.006 (0.004)		0.005 (0.004)
Plurality vs proportional rule		-0.003 (0.01)		-0.02 (0.02)		-0.02* (0.01)
Adjusted R squared	24	24	13	13	9.3	9.7
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	314	314	304	304	304	304
No. of countries	24	24	24	24	24	24
Robust F test						
2-ways vs country FE	3.77***	3.80***	3.34***	3.38***	2.81***	2.61***
2-ways vs time FE	2.72***	3.00***	2.51***	2.34***	3.05***	2.61***
2-ways vs pooled	3.39***	4.38***	3.39***	3.31***	3.16***	2.83***
Breusch-Pagan test	92***	98***	36	38	78***	83***
Panel Ljung-Box test	2.00	1.22	0.59	1.00	0.44	0.80
Panel Shapiro-Wilk test	-2.24**	-2.46**	-2.40**	-2.29**	-1.47*	-1.41*
Bias & inefficiency test LSDV	251***	263***	183***	113***	392***	329***

Notes: Dependent variable and per capita GDP are in first differences of logs. 2-way fixed effects (FE) estimation with the statistically robust MM estimator using an outlier-robust covariance estimator proposed by Cribari-Neto, Da Silva (2011) that corrects for heteroskedasticity. t tests: figures in parentheses are robust SE; a robust F test is used as a test for redundancy of fixed-effects test and a regressor group; H0: FE/ regressor group are/ is redundant; Breusch-Pagan tests with 2-way FE, H0: no heteroskedasticity, BP test statistic; Panel Ljung-Box test based on Hartung's combining p-test (Hartung, 1999); H0: no autocorrelation, combining t-test statistic; Panel Shapiro-Wilk test based on Hartung's combining p-test, H0: Gaussian distribution, combining t-test statistic; Bias & inefficiency test (Maravina, 2012; T1 test), H0: Gaussian distribution; rejection of H0 means LSDV estimator is inefficient or inefficient and biased, chi-squared test statistic.

***:= 1% significance level; **:= 5% significance level; *:= 10% significance level.
Note that regressions with a HAC estimator provides qualitatively similar result.

[a] We use the employment share of total services to construct the adjusted Baumol variable.

Table 2 *continued I*

	Dependent variable: public expenditure by function					
	General administration		Public order & safety		Environment protection	
Model	a	b	a	b	a	b
Adjusted Baumolvariable	0.09 (0.07)	0.10 (0.07)	0.05 (0.05)	0.06 (0.05)	0.16 (0.12)	0.24* (0.13)
Real per capita GDP	0.06 (0.24)	0.09 (0.24)	0.47*** (0.17)	0.38** (0.18)	0.92** (0.43)	1.04** (0.44)
Unemployment rate	0.06** (0.03)	0.06** (0.03)	0.005 (0.02)	0.004 (0.02)	-0.05 (0.05)	-0.05 (0.05)
Youth dependency ratio (until 15 to all ages)	-0.64 (0.42)	-0.67 (0.44)	0.27 (0.30)	0.48 (0.32)	-0.39 (0.77)	-0.21 (0.79)
Old-age dependency ratio (above 64 to all ages)	0.17 (0.29)	0.24 (0.30)	0.13 (0.21)	0.18 (0.21)	-0.26 (0.51)	-0.05 (0.53)
Government ideology						
Center vs left		-0.002 (0.02)		0.002 (0.01)		-0.05 (0.03)
Right vs left		-0.003 (0.008)		-0.009 (0.006)		-0.03* (0.01)
Election years		0.005 (0.006)		0.003 (0.004)		0.01 (0.01)
Plurality vs proportional rule		0.03 (0.02)		-0.01 (0.02)		-0.05 (0.04)
Adjusted R squared	6.3	5.5	6.6	7.5	0.0	-1.2
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	304	304	304	304	284	284
No. of countries	24	24	24	24	23	23
Robust F test						
2-ways vs country FE	1.60*	1.62*	1.45	1.27	1.30	1.30
2-ways vs time FE	2.82***	2.59***	2.81***	3.51***	1.19	1.19
2-ways vs pooled	2.22***	2.06***	2.64***	2.85***	1.24	1.24
Breusch-Pagan test	139***	159***	86***	91***	49	51
Panel Ljung-Box test	0.29	0.07	-0.50	-0.41	1.51	2.44
Panel Shapiro-Wilk test	0.84	0.64	-0.22	-0.73	1.97**	-2.61***
Bias & inefficiency test LSDV	84.5***	123***	497***	450***	33.4***	152***

Table 2 *continued II*

	Dependent variable: public expenditure by function			
	Recreation, culture & religion		Social security	
Model	a	b	a	b
Adjusted Baumolvariable	0.12* (0.07)	0.16** (0.07)	-0.03 (0.03)	-0.04 (0.03)
Real per capita GDP	0.68*** (0.25)	0.73*** (0.26)	0.32*** (0.11)	0.26** (0.12)
Unemployment rate	-0.03 (0.03)	-0.03 (0.03)	0.06*** (0.01)	0.06*** (0.01)
Youth dependency ratio (until 15 to all ages)	-0.24 (0.44)	-0.41 (0.46)	-0.19 (0.22)	-0.14 (0.23)
Old-age dependency ratio (above 64 to all ages)	0.23 (0.30)	0.22 (0.31)	-0.10 (0.15)	-0.13 (0.15)
Government ideology				
Center vs left		-0.03 (0.02)		0.01 (0.007)
Right vs left		-0.004 (0.008)		0.003 (0.004)
Election years		0.00 (0.006)		0.002 (0.003)
Plurality vs proportional rule		-0.05** (0.02)		0.002 (0.01)
Adjusted R squared	5.1	3.9	16	15
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
No. of obs.	304	304	314	314
No. of countries	24	24	24	24
Robust F test				
2-ways vs country FE	1.62**	1.32	2.24***	2.02***
2-ways vs time FE	1.21	1.53*	3.33***	3.14***
2-ways vs pooled	1.36	1.64**	3.33***	3.09***
Breusch-Pagan test	65**	67*	60*	60
Panel Ljung-Box test	1.89	1.86	-2.07**	-2.63***
Panel Shapiro-Wilk test	-3.39***	-3.12***	-1.49*	-1.31
Bias & inefficiency test LSDV	233***	173***	125***	185***

Table 3: The impact of Baumol's cost disease on government expenditure – further estimations

	Dependent variable: public expenditure by function					
	Total		Health		Education	
Model	a	b	a	b	a	b
Adjusted Baumolvariable[a]	0.03** (0.01)	0.04*** (0.01)	0.07*** (0.02)	0.07*** (0.02)	0.04** (0.02)	0.04** (0.02)
Real per capita GDP	0.54*** (0.11)	0.49*** (0.11)	0.91*** (0.16)	0.89*** (0.17)	0.68*** (0.15)	0.64*** (0.16)
Unemployment rate	0.02 (0.01)	0.01 (0.02)	0.005 (0.02)	0.003 (0.02)	-0.006 (0.02)	-0.006 (0.02)
Youth dependency ratio (until 15 to all ages)	-0.17 (0.21)	0.06 (0.21)	0.83*** (0.29)	0.87*** (0.31)	0.22 (0.27)	0.25 (0.28)
Old-age dependency ratio (above 64 to all ages)	-0.01 (0.14)	0.05 (0.14)	0.40** (0.20)	0.40* (0.21)	0.22 (0.18)	0.23 (0.19)
Government ideology						
Center vs left		0.005 (0.006)		0.003 (0.01)		-0.002 (0.01)
Right vs left		-0.003 (0.004)		-0.005 (0.005)		-0.006 (0.005)
Election years		0.004 (0.003)		0.005 (0.004)		0.005 (0.004)
Plurality vs proportional rule		0.004 (0.003)		-0.02 (0.02)		-0.02 (0.01)
Adjusted R squared	25	24	12	13	8.0	8.7
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	311	311	301	301	301	301
No. of countries	23	23	23	23	23	23
Breusch-Pagan test	91***	97***	36	38	77***	82***
Panel Ljung-Box test	2.04	1.24	0.49	0.92	0.44	0.27
Panel Shapiro-Wilk test	-1.92**	-2.40**	-2.67***	-2.51***	-1.79**	-1.76**
Bias & inefficiency test LSDV	207***	221***	146***	95***	8.0	62***

Notes: Dependent variable and per capita GDP are in first differences of logs. 2-way fixed effects (FE) estimation with the statistically robust MM estimator using an outlier-robust covariance estimator proposed by Cribari-Neto, Da Silva (2011) that corrects for heteroskedasticity. t tests: figures in parentheses are robust SE; a robust F test is used as a test for redundancy of fixed-effects test and a regressor group; H0: FE/ regressor group are/ is redundant; Breusch-Pagan tests with 2-way FE, H0: no heteroskedasticity, BP test statistic; Panel Ljung-Box test based on Hartung's combining p-test (Hartung, 1999); H0: no autocorrelation, combining t-test statistic; Panel Shapiro-Wilk test based on Hartung's combining p-test, H0: Gaussian distribution, combining t-test statistic; Bias & inefficiency test (Maravina, 2012; T1 test), H0: Gaussian distribution; rejection of H0 means LSDV estimator is inefficient or inefficient and biased, chi-squared test statistic.
***:= 1% significance level; **:= 5% significance level; *:= 10% significance level.
Note that regressions with a HAC estimator provides qualitatively similar result.

[a] We use the employment share of community, personal and social services to construct the adjusted Baumol variable.

Table 3 *continued I*

	Dependent variable: public expenditure by function					
	General administration		Public order & safety		Environment protection	
Model	a	b	a	b	a	b
Adjusted Baumolvariable	0.006 (0.03)	0.004 (0.03)	0.01 (0.02)	0.02 (0.02)	0.07 (0.05)	0.11* (0.06)
Real per capita GDP	0.22 (0.23)	0.18 (0.25)	0.44*** (0.37)	0.36** (0.17)	0.92** (0.43)	1.00** (0.45)
Unemployment rate	0.06* (0.03)	0.05* (0.03)	0.009 (0.02)	0.004 (0.02)	-0.05 (0.05)	-0.05 (0.06)
Youth dependency ratio (until 15 to all ages)	-0.55 (0.42)	-0.34 (0.44)	0.25 (0.31)	0.48 (0.31)	-0.36 (0.77)	-0.39 (0.80)
Old-age dependency ratio (above 64 to all ages)	0.11 (0.28)	0.19 (0.30)	0.12 (0.21)	0.18 (0.21)	-0.25 (0.52)	-0.07 (0.53)
Government ideology						
Center vs left		-0.006 (0.02)		0.004 (0.01)		-0.05* (0.03)
Right vs left		-0.007 (0.007)		-0.008 (0.006)		-0.01* (0.03)
Election years		0.008 (0.006)		0.002 (0.004)		0.009 (0.01)
Plurality vs proportional rule		0.03 (0.02)		-0.01 (0.02)		-0.05 (0.04)
Adjusted R squared	6.7	5.7	6.9	7.8	0.0	-1.2
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	301	301	301	301	281	281
No. of countries	23	23	23	23	22	22
Breusch-Pagan test	138***	157***	84***	90***	49	51
Panel Ljung-Box test	0.27	0.18	-0.39	-0.54	1.51	2.21
Panel Shapiro-Wilk test	0.49	0.78	0.31	-0.45	-2.06**	-2.61***
Bias & inefficiency test LSDV	208***	197***	674***	586***	36.2***	39***

Table 3 *continued II*

	Dependent variable: public expenditure by function			
	Recreation, culture & religion		Social security	
Model	a	b	a	b
Adjusted Baumolvariable	0.05* (0.03)	0.07** (0.03)	0.02 (0.01)	-0.02 (0.23)
Real per capita GDP	0.76*** (0.25)	0.82*** (0.26)	0.61*** (0.11)	0.25** (0.12)
Unemployment rate	-0.03 (0.03)	-0.03 (0.03)	0.04*** (0.01)	0.06*** (0.01)
Youth dependency ratio (until 15 to all ages)	-0.28 (0.45)	-0.54 (0.47)	-0.04 (0.22)	-0.15 (0.23)
Old-age dependency ratio (above 64 to all ages)	0.19 (0.30)	0.16 (0.31)	-0.09 (0.15)	-0.13 (0.16)
Government ideology				
Center vs left		-0.02 (0.02)		0.01 (0.007)
Right vs left		-0.002 (0.008)		0.002 (0.004)
Election years		-0.001 (0.006)		0.002 (0.003)
Plurality vs proportional rule		-0.04* (0.02)		0.002 (0.01)
Adjusted R squared	5.1	4.4	15	15
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
No. of obs.	301	301	311	311
No. of countries	23	23	23	23
Breusch-Pagan test	64**	66*	60*	60
Panel Ljung-Box test	1.71	1.92	-2.14**	-2.55**
Panel Shapiro-Wilk test	-3.05***	-3.39***	-2.02**	-1.59*
Bias & inefficiency test LSDV	154***	162***	995***	205***