Baumol's cost disease and the sustainability of the welfare state*

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Abstract

If productivity increases more slowly for services than for manufactured goods then services suffer from Baumol's cost disease and tend to become relatively more costly over time. Since the welfare state in all countries is an important supplier of tax financed services, this translates into a financial pressure which seems to leave policymakers with a trilemma; increase tax distortions, cut spending or redistribute less. Under the assumptions underlying Baumol's cost disease, we show that these dismal implications are not warranted. The welfare state is sustainable and there is even scope for Pareto improvements under Baumol's cost disease.

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> An economic specter haunts the democratic governments of the world's most prosperous economies. The rising cost of health care and education casts a shadow over virtually any election......ever more of gross national product will have to be channeled through the public sector, with all the problems we know that to entail (Baumol, 1993, p. 17).

1 Introduction

Does Baumol's cost disease bring the sustainability of the welfare state at risk? Baumol (1967) raised the issue of how society would develop if there are ongoing productivity increases in the production of manufactured commodities and no (or lower) productivity increases in the production of services.[1] If wage increases are the same across sectors, it follows that the cost or price of services increases relative to manufactured commodities. A mechanism known as Baumol's cost disease. Baumol predicted an ever declining employment level in manufacturing, increasing employment in the service sector, and eventually a stagnant economy. Although the Baumol cost disease applies to services in general, and not whether they are provided by the private or the public sector, a number of authors have pointed to the particular difficulties it raises for tax financed service provision. Baumol (1993) predicts that an ever increasing share of the gross domestic product will be absorbed by the public sector, and thus eventually lead to a tax rate in conflict with the Laffer bound. Similar arguments are made in e.g. Lindbeck (2006) and van der Ploeg (2007).

Empirical evidence confirms Baumol's productivity assumption and the implied structural changes. Empirical analyses show that services in general tend to have lower productivity growth than other goods and therefore service prices tend to grow faster, see e.g. Nordhaus (2008). Structural changes leading to a declining employment share in manufacturing sectors (in a broad sense including both primary and secondary sectors) and increasing employment shares in private and public services are observed for all OECD countries. It is also noteworthy that assessments of fiscal sustainability commonly point to Baumol's cost disease as an important expenditure driver, see e.g. IMF

[1] See also Baumol and Bowen (1966), Baumol (1993) and Baumol et al. (2012).

(2012) and European Commission (2013) as well as a long list of specific country studies including Bates and Santerre (2013) on the US, Office of Budget Responsibility (2013) on the UK, New Zealand Treasury (2012) on New Zealand, DREAM (2014) on Denmark, and Regeringen (2013) on Sweden.

The implications of Baumol's cost disease seem to be dismal, stagnating economies and unsustainable public sectors. The stagnation implication has been reputed. Even accepting the premise of differences in productivity growth between manufactured goods and services as well as increasing employment shares in services, it does not necessarily follow that economies will stagnate. Ngai and Pissarides (2007) show that both facts are consistent with ongoing growth when accounting for capital goods needed in both manufacturing and service production.

We consider the implications of Baumol's cost disease for the public sector or the welfare state in more general terms. We interpret the welfare state broadly in the sense of tax financed provision of services (including education, health and care) as well as redistribution. All OECD countries have welfare states although obviously the size and structure differ. If the relative costs of producing publicly provided services grow over time, it seems to bring the welfare state into a financial squeeze leaving a trilemma for policy makers; increase tax distortions, cut spending on services or redistribute less. The latter two choices amount to a retrenchment of the welfare state, which may seem unavoidable because the tax-income ratio has an upper limit (the Laffer rate).

We ask whether the welfare state is sustainable in the sense that the same level of public provision of services can be maintained, that no individual gets lower utility (the distribution of well-being is maintained) and public finances are not compromised. A key contribution of the paper is the inclusion of income heterogeneity and the distributional motive. With a homogenous population a lump-sum tax would be unproblematic, and hence the financing of the public sector would not be associated with distortions. We adopt the original Baumol assumptions on productivity growth–labelled Baumol growth–and consider the implications for the welfare state under general assumptions on individual preferences. We show that Baumol growth does not bring the sustainability of the welfare state at risk. The welfare state is sustainable and, moreover, Baumol growth leaves room for Pareto improvements. Some of the possible Pareto improvements are characterized by a higher level of public service and a higher spending share on public service.

Our results are related to recent work showing that the marginal cost of public funds and the efficiency loss from taxation may be exaggerated when taking marginal tax rates at face value and, more generally, pointing to the virtues of generous welfare states, e.g. Kaplow (2004), Blomquist et al. (2010), Kreiner and Verdelin (2012), Jacobs (2013), Jacobs and de Mooij (2014), Barth et al. (2014) and Kleven (2014). In the case considered here, Baumol growth increases the cost of public services and therefore government expenditures, but it also changes household income and thereby tax revenue and demand for public services. The effects on household welfare vary across households with different income levels. By using benefit off-setting income taxation (related to the use of the benefit principle or Lindahl pricing in public good provision), we show it is possible to keep utility unchanged at all income levels and increase tax payments without impeding economic efficiency. The increase in tax revenue is always larger than the increase in government expenditures thereby leaving room for Pareto improvements.[2]

The paper is organized as follows: The model featuring Baumol growth and a public sector engaged both in public provision of services and redistribution is set up in Section 2. The results on the sustainability of the welfare state under Baumol growth and the scope for Pareto improvements are provided in Section 3, while Section 4 offers some concluding remarks.

2 A model of Baumol growth and public policies

The welfare state provides welfare services and redistributes. To capture both elements we formulate a model in which agents derive utility from a tax-financed public good or service and have different earnings ability giving a motive for redistribution. Ability levels are unobservable by the benevolent policy maker, who uses income taxes to

[2] The related literature on the marginal cost of public funds (MCF) has shown that the MCF equals one when utility is separable between consumption goods (including consumption of public goods) and leisure. Our results, showing that the welfare state is sustainable under Baumol growth and always leaves room for Pareto improvements, do not hinge on any separability assumption.

redistribute across individuals. This leads to the classical equity-efficiency trade-off studied in optimal income taxation. We consider a two-goods economy with a private good (labelled manufactured good) and a public good/service (labelled service).[3] The productivity may increase for both types of production, but our main focus will be on the case of Baumol growth where productivity increases more in the production of manufactures than in service production.

2.1 Firms

The technologies available for production of manufactures (M) and services (S) are given as

$$Y_M = A_M L_M, \tag{1}$$

$$Y_S = A_S L_S, \tag{2}$$

where L_i denotes effective input of labour while A_i ($i = M, S$) captures productivity.

We normalize the price of the manufacturing good to one, and let p_S denote the price of the service relative to the manufacturing good. The cost per unit of effective labour is denoted w (measured in units of the numeraire good), and assuming that labour is completely mobile between the two sectors implies a uniform wage across the sectors. The first-order conditions for the profit maximization problem of firms become[4]

$$w = \partial Y_M / \partial L_M = A_M, \tag{3}$$

$$\frac{w}{p_S} = \partial Y_S / \partial L_S = A_S. \tag{4}$$

We consider exogenous technological progress:

$$dA_M / A_M = g_M,$$

$$dA_S / A_S = g_S,$$

[3] Since the population size is constant, the public activity may be interpreted as either a collective good or an individualized service like health, care or education.

[4] Note that with perfect competition and constant returns there is no difference between a situation where the public sector acquires services in the market or is the producer of the service. However, in the last case, we will assume in accordance with practical policy that the policy maker as an employer observe the ability levels of the employees, but does not exploit this information for the taxation of public employees. We apply the standard assumption in optimal income taxation that taxes can only depend on income and not on ability levels, and that this applies to all employees.

where *Baumol growth* is present whenever $g_M > g_S \geq 0$. From (3) and (4), we have

$$p_S = A_M/A_S \quad \Rightarrow \quad dp_S/p_S = g_M - g_S > 0, \tag{5}$$

showing that Baumol growth makes the service more expensive relative to the manufactured good.

From eqs (1), (2) and (5), we also have

$$\frac{p_S Y_S}{Y_M} = \frac{p_S A_S L_S}{A_M L_M} = \frac{L_S}{L_M},$$

showing that the service sector uses a larger fraction of labour if the value of service output increases as a fraction of GDP.[5]

2.2 Households

We consider a continuum of households which differ only with respect to abilities $n \in [\underline{n}, \overline{n}]$. Ability levels are fixed and distributed according to the density function $f(n)$ where $f(n) \geq 0$ and $\int_{\underline{n}}^{\overline{n}} f(n)dn = 1$. The effective labour input per hour of a type n individual is equal to n, implying that the wage per hour becomes

$$w(n) = w \cdot n = A_M n = p_S A_S n, \tag{6}$$

where we have used eqs (3) and (4). Notice that technological progress does not influence the gross wage differential between different types of labour, i.e. $w(n')/w(n'') = n'/n''$ is independent of A_M and A_S for all n' and n''. Thus, *Baumol growth* does not affect the distribution of relative wages (we do not want to mix up the effects of Baumol growth with the effects of skill-biased technological change).

The households have identical preferences represented by the utility function

$$u = u(m, s, l), \tag{7}$$

where m denotes private consumption of the manufactured good, s is consumption of services supplied by the government, and l is hours-of-work. The utility function is twice

[5] The Baumol effect does not necessarily raise the fraction of income used on public services. This often requires that the elasticity of substitution between the two types of goods in household demand is below one, e.g. Ngai and Pissarides (2007). Our main result, showing that Baumol growth always enables Pareto improvements, holds for a general preference specification, but we also discuss additional results that depend on the size of the elasticity of substitution.

continuously differentiable, $u_m > 0$, $u_s > 0$, $u_l < 0$, and the usual concavity and limit properties apply.

The budget constraint of an individual equals

$$m \leq e - T(e), \tag{8}$$

where $e \equiv A_M nl$ denotes gross earnings (cf. eq. (6)), while $T(e)$ is a non-linear tax function defined over earnings. From eqs. (7), (8) and $l = e/(A_M n)$, we get

$$MRS_{me}(e,s,n) \equiv -\frac{u_l(e-T(e),s,l)}{u_m(e-T(e),s,l)}\frac{1}{A_M n} > 0, \tag{9}$$

$$MRS_{ms}(e,s,n) \equiv \frac{u_s(e-T(e),s,l)}{u_m(e-T(e),s,l)} > 0, \tag{10}$$

which measures the marginal rate of substitution between, respectively, m and e, and m and s for a type n individual at the earnings level e. A household of type n chooses the earnings level $e(n)$ (or, equivalently, $l(n)$) and the consumption of manufacturing goods $m(n)$ that maximize (7) subject to (8), for a given level of public services s. The first-order condition gives

$$MRS_{me}[e(n),s,n] = 1 - \tau(e(n)), \tag{11}$$

where $\tau(e(n)) \equiv \partial T(e(n))/\partial e(n)$ is the marginal tax rate at the income level $e(n)$. We follow the standard approach in optimal income taxation and contract theory and assume that the Spence-Mirrlees single-crossing condition is satisfied (e.g. Salanié, 2003):

$$\partial MRS_{me}(e,s,n)/\partial n < 0. \tag{12}$$

This assumption ensures that the tax system is implementable; i.e., that higher ability individuals always choose higher equilibrium earnings, implying that the government can use income as a signal of the underlying ability.

The indirect utility function of individual n when consumption of the manufactured good and labour supply are chosen optimally is defined as

$$v(n) \equiv u\left(e(n) - T(e(n)), s, \frac{e(n)}{A_M n}\right), \tag{13}$$

which also implies

$$v_n(n) = -u_l(\cdot)\frac{e(n)}{A_M n^2} > 0, \tag{14}$$

where we have used the Envelope Theorem.

2.3 Market equilibrium

Market clearing in the factor market and in the market for the private good implies

$$L_M + L_S = \int_{\underline{n}}^{\bar{n}} nl(n) f(n) \, dn, \quad Y_M = \int_{\underline{n}}^{\bar{n}} m(n) f(n) \, dn.$$

2.4 Welfare state/government

The government decides the level of public service $s = Y_S$ and the non-linear tax function $T(\cdot)$, and thereby also the degree of redistribution. Since the government cannot observe ability levels, taxes and transfers depend on observable income, and redistribution of income therefore generates an efficiency loss. Note that $T(\cdot)$ may be negative at certain income levels, reflecting that households at these income levels receive net-transfers. The policy choice of the government has to obey the budget constraint

$$R \equiv \int_{\underline{n}}^{\bar{n}} T(e(n)) f(n) \, dn - p_S \cdot s \geq 0. \tag{15}$$

Various types of government activity are encompassed by the generality of the formulation of preferences. Note, for example, that it is both possible for high-income individuals to benefit the most from additional public expenditures and for low-income individuals to benefit the most. Note also that public service may be both non-rival or rival.[6]

Often utility is assumed to be separable between private (here m and l) and public consumption (s), in which case the latter may be interpreted as general public activities. By allowing for non-separable preferences, public activities may influence the marginal rate of substitution ($MRS_{me}(e,s,n)$) between consumption of manufactured goods (m) and income/leisure (e). If an increase in public services decreases (increases) the marginal rate of substitution, ceteris parisbus, labour supply increases (decreases).[7] Public

[6]To simplify the notation, we have normalized the population to one. However, our results still apply if we in the utility function divide total public expenditures s with a fixed population size N. Too see this, note that a utility function $u(m, s/N, l)$, where N is a constant, may be written as a new utility function $\tilde{u}(m, s, l)$.

[7]We have that

$$\frac{\partial MRS_{me}(e,s,n)}{\partial s} = -\left[\frac{u_{ls}(\cdot)\, u_m(\cdot) - u_l(\cdot) u_{ms}(\cdot)}{u_m^2(\cdot)}\right] \frac{1}{A_M n}$$

Hence, a necessary condition for $\frac{\partial MRS_{me}(e,s,n)}{\partial s} < 0$ is either $u_{ls}(\cdot) > 0$ and/or $u_{ms}(\cdot) > 0$, i.e. an day care, education and health are examples of public services which in this way may have a positive effect on labour supply. Public sector activities may also affect productivity, leading to endogenous growth mechanisms (Barro, 1990). Such effects are not included in the model, but could be incorporated by changing the wage relation (6) to read $w(n) = wh(s)n$, where $h(s)$ captures education/human capital depending on public education s. This would further reinforce our main result below.

3 Sustainability of the welfare state

For a given government policy s and $T(\cdot)$, the market equilibrium is fully characterized by an equilibrium allocation of household consumption of manufacturing goods $m(n)$ and earnings $e(n)$ for all ability levels n, where households of type n obtain the utility level $v(n)$. Starting from such an allocation, we define the welfare state to be sustainable under *Baumol growth* if it is possible to keep the level of public service s unchanged and at the same time maintain an unchanged utility level $v(n)$ for all ability levels n, and thus an unchanged distribution of utility, without violating the government budget constraint. In addition, we analyse whether *Baumol growth*, after an appropriate adjustment of the tax and public expenditure policy, enables a Pareto improvement or, alternatively, that a Pareto worsening is unavoidable. Our main result is

Proposition 1 (i) *The welfare state is sustainable under Baumol growth: it is possible to keep the level of public service s unchanged–although public expenditures grow more than private expenditures–and maintain an unchanged distribution of well-being $v(n)$ for all ability levels n without violating the government budget constraint* (15). (ii) *It is always possible to obtain Pareto improvements from Baumol growth, and some of these Pareto improvements include a higher level of public services s.*

To establish this result, we employ a dual approach. We do this below in three steps. First, we derive a new allocation of private consumption levels $m(n)$ and earnings levels $e(n)$ that keep well-being $v(n)$ fixed at its original level for all ability types n under

increase in public services decreases the marginal disutility of work or increases the marginal utility of consumption.

Baumol growth, and for an unchanged level of public service s. Second, we derive the change in the tax burden and the marginal tax rate of each individual n required to implement the new allocation. Third, we show that the change in taxation from the original allocation to the new allocation generates an increase in total tax revenue, which is *strictly* larger than the increase in expenditures to public service. This establishes directly part (i) of the proposition. Part (ii) follows from the fact that the increase in government revenue is always strictly larger than the increase in expenditures. This extra revenue may be used to increase the public service level s or to reduce taxation, and thereby achieve an allocation that Pareto dominates the original allocation.[8]

In the first step, we impose the condition that utility has to be unchanged after the change in the productivity levels. This implies that $dv(n) = 0$ and $dv_n(n) = 0$ when going from the original allocation to the new allocation. From eqs (13) and (14), this implies

$$dv(n) = u_m dm(n) + u_l \frac{de(n)}{A_M n} - \frac{u_l e(n)}{A_M n} g_M = 0, \tag{16}$$

$$\begin{aligned} dv_n(n) &= -u_{ml}\frac{e}{A_M n^2} dm(n) - u_l \frac{de(n)}{A_M n^2} - u_{ll}\frac{e \cdot de(n)}{A_M^2 n^3} \\ &\quad + \frac{u_l e(n)}{A_M n^2} g_M + u_{ll}\frac{e(n)^2}{A_M^2 n^3} g_M = 0, \end{aligned} \tag{17}$$

where $dm(n)$ and $de(n)$ are changes in the household allocation while $g_M = dA_M/A_M$ captures the change in productivity in the manufacturing sector. By using these two equations to solve for the two unknowns $m(n)$ and $e(n)$ for each n, we obtain

$$\frac{de(n)}{e(n)} = g_M, \tag{18}$$

$$dm(n) = 0, \tag{19}$$

showing that earnings have to grow with the same rate as productivity in the manufacturing sector, while consumption of the manufacturing good has to be unchanged.

Second, we solve for the adjustment in taxation needed to implement the above change in the household allocation. From the household budget constraint (8), we

[8] A reduction in taxation/increase in public service may affect labor supply and thereby have a negative effect on government revenue, but this effect will only be of second order.

obtain

$$dm(n) = (1 - \tau(e(n)))\, de(n) - dT(e(n)),$$

where $dT(e(n))$ denotes the change in the total tax burden at the earnings level $e(n)$. After using eqs (18) and (19) to substitute for de and dm, we obtain

$$dT(e(n)) = (1 - \tau(e(n))) \cdot e(n) \cdot g_M > 0. \tag{20}$$

This expression measures the compensating increase in the tax burden of a type n individual following the growth in productivity, i.e., the adjustment in taxation needed to capture the benefits of individual n from a higher productivity so as to keep the utility of the individual unchanged.

Third, we analyse how the change in productivity, together with the implied change in taxation and in the cost of producing public services, influences the government budget defined in (15). This gives

$$dR = \int_{\underline{n}}^{\bar{n}} [dT(e(n)) + \tau(e(n)) de(n)]\, f(n)\, dn - dp_S \cdot s,$$

where the first term in the bracket reflects the direct increase in tax payments at the different earnings levels, the second term in the bracket reflects the increase in tax revenue from higher earnings that are taxed at the marginal tax rate $\tau(\cdot)$, while the last term in the equation captures the increase in public service expenditures due to the increasing relative prices of services under Baumol growth.

Using eqs (5), (18) and (20), we may rewrite the above expression as

$$dR = g_M \int_{\underline{n}}^{\bar{n}} ef(n)\, dn - (g_M - g_S)\, p_S s > 0, \tag{21}$$

where the *strict* inequality follows from the fact that aggregate income $\int_{\underline{n}}^{\bar{n}} ef(n)\, dn$ is strictly larger than public expenditures $p_S s$. Thus, we have shown that it is possible, following Baumol growth, to implement an allocation where the public service level is unchanged, utility for all individuals is unchanged, while government revenue increase strictly more than government expenditures. Finally, two observations: First, the share of public expenditures out of total expenditures (GDP), $\Omega \equiv p_S Y_S / (Y_M + p_S Y_S)$, increases, since the relative price p_S increases under Baumol growth as described in (5), while Y_S and Y_M are unchanged. Second, since public revenue displays a surplus under the unchanged utility condition, it follows that there is scope for a Pareto improvement either by increasing the supply of services or by tax reductions. This completes the proof of the proposition.

An increasing expenditure share for public services is often given as the reason why the sustainability of the welfare state is at risk under Baumol growth.[9] The proposition shows that this does not follow, and that an increasing expenditure share is consistent with agents being no worse-off, and generally better off, compared to a situation without Baumol growth.

Another important property in the proof of the proposition is that labor supply of each individual is unchanged under the condition of unchanged utility.[10] Average tax rates increase at all earnings levels implying that marginal tax rates increase at least at some earnings levels. In isolation, this change in taxation affects labor supply through substitution and income effects, which may lower government tax revenue. However, the substitution and income effects are exactly counteracted by similar effects on labor supply going in the opposite directions and coming from the productivity increases. To see this intuitively, note that the tax change at each earnings level is constructed such that the after-tax income is the same as before the change in productivity. It then follows that the relationship between private consumption and gross earnings in the budget constraint is unchanged, implying that each individual chooses the same labor supply.

Note that Proposition 1 applies under reasonably weak assumptions; e.g., we have not imposed strong assumptions on individual preferences such as weak separability as often done in related literature, and the result does not rely on interpersonal utility trade-offs embodied in social welfare functions, but only on a Pareto dominance criterion.

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[9] Note that the concerns often associated with Baumol's cost disease, that is, stagnation and an ever increasing share of public expenditures, do not follow in a more generalized environment. Ngai and Pissarides (2007) show that stagnation does not follow when allowing for capital inputs in both production of manufactures and services. In Andersen (2016) it is shown that the expenditure share is upward bounded when allowing for both services provided by the public and the private sector.

[10] Follows by noting that $e = A_M nl$ and that the equal utility condition implies that $g_e = g_M$ which implies that l is constant.

The result in Proposition 1 establishes that it is always possible to achieve a Pareto improvement from Baumol growth for an arbitrary initial allocation with a given supply of services and a given tax structure (and thus tax revenue financing the service provision). This does not necessarily imply that the allocations before and after the change are Pareto optimal. In particular, the level of public service s may be too high or too low. However, since Proposition 1 applies for any initial level of public service s, it also holds for the socially optimal level. Using the Pareto criterion, it is possible to show that an optimal level of public service satisfies (see Appendix A)

$$\int_{\underline{n}}^{\bar{n}} \left[MRS_{ms}\left(e\left(n\right), s, n\right) + \tau\left(e\left(n\right)\right) \frac{\partial MRS_{ms}\left(e, s, n\right)/\partial n}{\partial MRS_{me}\left(e, s, n\right)/\partial n} \right] f\left(n\right) dn = p_S, \qquad (22)$$

which is the modified Samuelson rule that has been derived elsewhere in the Public Finance literature, e.g. Kreiner and Verdelin (2012). The RHS is the marginal rate of transformation of the manufactured good into the public service and the first term in the bracket on the LHS is the aggregate willingness to pay for the public good. These two terms alone constitute the original Samuelson rule, while the second term in the bracket stems from the incomplete information of the government concerning ability levels that give rise to tax distortions.[11]

Consider now an initial allocation that is Pareto optimal, implying that condition (22) is fulfilled. In this case, Proposition 1 still applies and it is therefore always possible, following Baumol growth, to find new allocations that Pareto dominate the initial allocation. However, not all of these new allocations fulfill condition (22). In that case, it is possible to obtain an additional Pareto improvement by a readjustment of s and $T(\cdot)$, and moving to an allocation that fulfills condition (22).

This change may involve a change in the funds spend on public service. Thus, a question is whether a move from an initial allocation that is Pareto optimal, and therefore fulfills condition (22), to a new allocation, which is also Pareto optimal, will involve an increase in the expenditure share of public service. To address this issue, we

[11] The denominator in the second term is negative due to the single-crossing condition (12), and the sign of the tax distortion effect is therefore determined by $\partial \mathrm{MRS}_{ms}/\partial n$, which can be both positive and negative. In the special case of weak separability, where $u(m, s, l) = \tilde{u}(h(m, s), l)$, the tax distortion effect is zero, and the original Samuelson rule applies, see e.g. Christiansen (1981) and Boadway and Keen (1993).

consider a special case with a CES subutility function over manufacturing goods m and services s, also studied by for example Ngai and Pissarides (2007), specified as

$$u = \tilde{u}\left(\left(\alpha m^{\frac{\sigma-1}{\sigma}} + (1-\alpha)\, s^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}, l\right), \tag{23}$$

where $\tilde{u}(\cdot)$ has standard properties. With this utility function, we consider Baumol growth and a policy change that keeps utility of each individual unchanged as in Proposition 1, but where s is required to fulfill the modified Samuelson rule (22) both before and after the change. Note that in our model with heterogeneity in ability levels, this case is more complicated than in representative agent models, because private consumption m and labor supply l vary across ability levels, while public service s is the same for all individuals. In line with other studies, we show in Appendix B that the share of public expenditures out of total expenditures $\Omega \equiv p_S Y_S / (Y_M + p_S Y_S)$ is constant when the elasticity of substitution is unity, $\sigma = 1$. The expenditure share increases when the degree of substitution is lower. Thus, with a low degree of substitution between private consumption and public service, it is possible to obtain a Pareto improvement from Baumol growth by going from one Pareto optimal allocation to another Pareto optimal allocation that involves a higher expenditure share.

4 Concluding remarks

There is widespread concern that Baumol's cost disease will lead to increasing taxes and thus tax distortions, which makes it difficult to sustain the welfare state. We have shown, under fairly general assumptions, that this inference does not follow. The productivity increases underlying Baumol's costs disease always leaves scope for Pareto improvements. For any initial level of public provision of services and tax structure–and thus distributional profile–to finance these services, society is not made worse off by Baumol growth. The initial provision of public services and the distribution of well-being can be maintained, at the same time as tax revenue is raised so that public revenue improves net of the relative cost increase for services. The new allocation is characterized by an increasing expenditure share of public services and unchanged labour supply for all individuals. Moreover, the extra government revenue may be used to increase provision of public services or reduce taxes thereby achieving an even better allocation, i.e. a Pareto improvement. The specific choice would depend on the relevant social welfare function.

It is striking that the basic result of the paper holds irrespective of the process underlying the choice of public service provision and determination of the tax structure, i.e. the size and structure of the welfare state may be determined under a Pareto criterion, utilitarian welfare function or some political economy model. This does not matter for the main result; it is always possible to maintain the initial supply of services and distribution of welfare under Baumol growth, and there is scope for Pareto improvements. This result would only be reinforced if public expenditures were also associated with efficiency gains or endogenous growth mechanisms.

The above results have been derived in a setting with heterogenous agents (different abilities/productivities) to capture the distributional dimension crucial to the welfare state. To this end, it turns out to be convenient to work with a framework with a continuum of agents, and under fairly general assumptions concerning preferences, the above mentioned results have been established. We have adopted a standard Mirrleesian type setting with homogenous preferences and heterogeneity in innate abilities. A model with heterogeneity along both dimensions would be considerably more complex. In such a setting, it would be very difficult to derive results based solely on the Pareto criteria because willingness-to-pay for public services would differ across households with the same level of income and therefore the same tax payment.

Our analysis relies on the flexibility of non-linear income tax schemes, which makes it possible to adjust tax payments at any income level to match changes in willingness to pay for public service, i.e. the benefit principle may be applied. It may be argued that this assumption—also underlying the Mirrleesian optimal income tax framework—requires more flexibility in income taxation than what is actually possible, e.g. Slemrod and Yitzhaki (2001). While we recognize there may be limits on the flexibility of the tax system in practice, the point of our analysis is to show that Baumol growth does not inevitably lead to unsustainability of the welfare state.

Our second-best analysis includes distortions in labor supply and in the composition of consumption between private sector goods and public sector goods. Both distortions are related to the revenue side of the public sector and vanishes in the special case of a perfectly inelastic labour supply. Another potential challenge may be on the expenditure side of the public sector where the optimal allocation of resources may be hampered by the lack of clear price signals, competitive pressure etc. implying a larger public sector may be detrimental to economic efficiency, e.g. Sørensen (2015).

A Derivation of equation (22)

Our derivation of the modified Samuelson rule follows the approach in Kreiner and Verdelin (2012). We consider a small (marginal) increase in s and a change in the tax function $T(\cdot)$ that keeps the utility level $v(n)$ fixed at all ability levels n. If such a change raises government revenue, then it is possible to make a Pareto improvement, implying that the initial level of s is socially suboptimal. If, on the other hand, government revenue decreases, then a Pareto improvement can be achieved by decreasing s. Hence, if the level of public service is set optimally, a Pareto improvement is not possible.

From the government budget constraint (15), we have

$$dR \equiv \int_{\underline{n}}^{\bar{n}} \left(dT\left(e\left(n\right)\right) + \tau\left(e\left(n\right)\right) de\left(n\right)\right) f\left(n\right) dn - p_S \cdot ds, \tag{A-1}$$

where $dT\left(e\left(n\right)\right)$ is the mechanical change in tax burden at the income level $e\left(n\right)$ while $\tau\left(e\left(n\right)\right) de\left(n\right)$ is the change in government revenue due to behavioural responses.

Unchanged utility at all ability levels implies from eqs. (13) and (14) that the change in the allocation satisfies

$$dv\left(n\right) = u_m dm + u_s ds + u_l \frac{de(n)}{A_M n} = 0, \tag{A-2}$$

$$dv_n\left(n\right) = -\left[u_{ml} dm + u_{sl} ds + u_{ll} \frac{de(n)}{A_M n}\right] \frac{e(n)}{A_M n^2} - u_l \frac{de(n)}{A_M n^2} = 0, \tag{A-3}$$

for all n.[12] By isolating dm in the first of these equations and substituting the result into the second equation, we obtain

$$de(n) = \left[\frac{u_{sl} - u_{ml}\frac{u_s}{u_m}}{u_{ml}\frac{u_l}{u_m}\frac{1}{A_M n} - u_{ll}\frac{1}{A_M n} - u_l \frac{1}{e}}\right] ds. \tag{A-4}$$

[12] These two conditions also ensure that the post-reform allocation is incentive compatible (see Kreiner and Verdelin, 2012).

From eqs. (9) and (10), we have

$$\begin{aligned}\frac{\partial MRS_{ms}(e,s,n)}{\partial n} &= -\frac{e}{u_m A_M n^2}\left[u_{sl} - u_{ml}\frac{u_s}{u_m}\right] \\ \frac{\partial MRS_{me}(e,s,n)}{\partial n} &= -\frac{e}{u_m A_M n^2}\left[u_{ml}\frac{u_l}{u_m}\frac{1}{A_M n} - u_{ll}\frac{1}{A_M n} - \frac{u_l}{e}\right].\end{aligned}$$

By inserting these two derivatives in (A-4), we obtain

$$de(n) = \frac{\partial MRS_{ms}(e,s,n)/\partial n}{\partial MRS_{me}(e,s,n)/\partial n}ds. \tag{A-5}$$

The household budget constraint $m = e - T(e)$ implies that $dm = (1-\tau)\,de - dT(e)$. This expression and the first order condition (11) enable us to write condition (A-2) as

$$dT(e(n)) = \frac{u_s(\cdot)}{u_m(\cdot)}ds = MRS_{ms}(e,s,n)\cdot ds. \tag{A-6}$$

This equation shows that the increase in the tax burden of an individual with earnings e is exactly equal to the extra benefit from the expansion of government consumption.

By inserting eqs. (A-5) and (A-6) into (A-1), we obtain

$$\frac{dR}{ds} = \int_{\underline{n}}^{\bar{n}}\left(MRS_{ms}(e(n),n) + \tau(e(n))\frac{\partial MRS_{ms}(e,s,n)/\partial n}{\partial MRS_{me}(e,s,n)/\partial n}\right)f(n)\,dn - p_S.$$

If $dR/ds > 0$, then it is possible to make a Pareto improvement by increasing s, and if $dR/ds < 0$, then it is possible to make a Pareto improvement by reducing s. Hence, a Pareto optimum is characterized by $dR/ds = 0$, which gives the result in eq. (22).

B Special case with CES subutility function

With the CES utility function (B-7), we obtain

$$MRS_{ms}(e,s,n) = \frac{1-\alpha}{\alpha}\left(\frac{s}{m}\right)^{-\frac{1}{\sigma}}. \tag{B-7}$$

After inserting the budget line (8), $MRS_{ms}(e,s,n) = \frac{1-\alpha}{\alpha}\left(\frac{s}{e-T(e)}\right)^{-\frac{1}{\sigma}}$ implying that $\partial MRS_{ms}(e,s,n)/\partial n = 0$, in which case the Samuelson rule (22) becomes

$$\int_{\underline{n}}^{\bar{n}}\frac{1-\alpha}{\alpha}\left(\frac{s}{m}\right)^{-\frac{1}{\sigma}}f(n)\,dn = p_S,$$

where we suppress the dependency of m on n. Differentiation of this rule gives the following relationship between the changes in public service g_s and private consumption $g_{m(n)}$ and the changes in technology g_M and g_S:

$$-\frac{1}{\sigma}\frac{\int_{\underline{n}}^{\bar{n}}\left(\frac{s}{m}\right)^{-\frac{1}{\sigma}}(g_s-g_m)\,f(n)\,dn}{\int_{\underline{n}}^{\bar{n}}\left(\frac{s}{m}\right)^{-\frac{1}{\sigma}}f(n)\,dn}=g_M-g_S. \tag{B-8}$$

From the utility function (B-7) and the condition that utility is fixed, we obtain

$$g_m=-\frac{1-\alpha}{\alpha}\left(\frac{s}{m}\right)^{\frac{\sigma-1}{\sigma}}g_s, \tag{B-9}$$

where we have used $dl=0$ due to weak separability of the utility function. By inserting this result in (B-8), we get

$$\int_{\underline{n}}^{\bar{n}}m^{\frac{1}{\sigma}}\left(\sigma(g_M-g_S)+g_s\left(1+\frac{1-\alpha}{\alpha}\left(\frac{s}{m}\right)^{\frac{\sigma-1}{\sigma}}\right)\right)f(n)\,dn=0, \tag{B-10}$$

which implicitly determines g_s.

The expenditure share of public service given by

$$\Omega=\frac{p_s s}{\int_{\underline{n}}^{\bar{n}}mf(n)\,dn+p_s s},$$

which after differentiation gives the following percentage change in the expenditure share

$$g_h=\frac{\int_{\underline{n}}^{\bar{n}}m\,(g_{p_s}+g_s-g_m)\,f(n)\,dn}{\int_{\underline{n}}^{\bar{n}}mf(n)\,dn+p_s s}.$$

By using (5) and (B-9) to substitute for g_{p_s} and g_m, we obtain

$$g_h=\frac{\int_{\underline{n}}^{\bar{n}}m\left(g_M-g_S+g_s\left(1+\frac{1-\alpha}{\alpha}\left(\frac{s}{m}\right)^{\frac{\sigma-1}{\sigma}}\right)\right)f(n)\,dn}{\int_{\underline{n}}^{\bar{n}}mf(n)\,dn+p_s s}.$$

The numerator of this expression is equal to (B-10) when $\sigma=1$. Thus, with a unitary substitution elasticity, the expenditure share is unchanged, $g_h=0$.

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