March 2025

Fondazione Eni Enrico Mattei

Working Paper

07.2025

Government Size, Civic Capital and Economic Performance: An O-ring approach

Luciano Mauro, Francesco Pigliaru, Gaetano Carmeci

Government Size, Civic Capital and Economic Performance: An O-ring approach

Luciano Mauro (Università di Trieste, DISPES and Duke University), **Francesco Pigliaru** (Università di Cagliari and CRENoS), **Gaetano Carmeci** (Università di Trieste, DEAMS)

Summary

This paper explores how civic capital shapes the relationship between government size and economic performance. Building on an exogenous-growth version of Barro (1990), we incorporate O-ring technology to capture task complementarity in the public sector, highlighting the role of civic capital in reducing errors and malfeasance. Our model shows that greater civicness not only raises the inverted U-shaped relationship between government size and output but also shifts it rightward, increasing both economic performance and the optimal government size. We test these implications using a dynamic panel data model for 23 OECD countries from 1975 to 2010, estimated via system GMM. Our results support the hypothesized inverted-U relationship and demonstrate that civic capital significantly raises the threshold at which the marginal returns to government size approach zero. Thus, countries with higher civicness can sustain larger public sectors without compromising growth. This finding provides fresh insights into how deeply institutional quality, rooted in social trust, shapes the government-size–growth nexus.

Keywords: Social capital, Government size, O-ring theory, Economic growth

JEL classification: O43, E02, H11, H21

Corresponding Author
Luciano Mauro
Università degli Studi di Trieste
Piazzale Europa 1, 34127 Trieste
(Italy)
luciano.mauro.ts@gmail.com

Government Size, Civic Capital and Economic Performance: An O-ring approach

Luciano Mauro,* Francesco Pigliaru,** and Gaetano Carmeci***

*Università di Trieste, DISPES, Italy and Duke University, US

**Università di Cagliari and CRENoS, Italy

***Università di Trieste, DEAMS, Italy

March 3, 2025

Abstract

This paper explores how civic capital shapes the relationship between government size and economic performance. Building on an exogenous-growth version of Barro (1990), we incorporate O-ring technology to capture task complementarity in the public sector, highlighting the role of civic capital in reducing errors and malfeasance. Our model shows that greater civicness not only raises the inverted U-shaped relationship between government size and output but also shifts it rightward, increasing both economic performance and the optimal government size. We test these implications using a dynamic panel data model for 23 OECD countries from 1975 to 2010, estimated via system GMM. Our results support the hypothesized inverted-U relationship and demonstrate that civic capital significantly raises the threshold at which the marginal returns to government size approach zero. Thus, countries with higher civicness can sustain larger public sectors without compromising growth. This finding provides fresh insights into how deeply institutional quality, rooted in social trust, shapes the government-size–growth nexus.

Keywords: Social capital, Government size, O-ring theory, Economic growth

JEL Codes: O43, E02, H11, H21

Disclaimer: The authors declare that they have no relevant or material financial interests that relate to the research described in this paper.

Declaration of Competing Interest: The authors declare that they have no known competing financial interests or personal relationships that could appear to influence the work reported in this paper.

Corresponding author: Luciano Mauro, luciano.mauro.ts@gmail.com, tel. No. +393471414714

Other authors' e-mail: Gaetano Carmeci, gaetano.carmeci@deams.units.it; Francesco Pigliaru, pigliaru@unica.it

1. Introduction

The impact of government size on economic performance has been extensively studied in the economic literature (Bergh and Henrekson,2011). This topic continues to attract significant attention, both in academic research and in political discourse, especially in light of recent trends in public spending across many countries (The Economist, 2024).

Empirical evidence suggests a negative effect in developed countries, particularly OECD nations with large governments (Afonso and Furceri, 2010; Bergh and Henrekson, 2011; Fournier and Johansson, 2016). In lower-income countries with smaller governments, however, the relationship is often weaker, insignificant, or even positive (Besley and Persson, 2009; Christie, 2014; Facchini and Melki, 2013; Marica and Piras, 2018). Overall, the evidence supports the conditional convergence model, emphasizing government size as a key determinant of long-run equilibrium. Additionally, it aligns with models suggesting an inverted U-shaped relationship between government size and economic performance, as proposed by Barro (1990) and others (Armey et al., 1995; Rahn rt al., 1996; Scully, 1994,1996).[1]

The Scandinavian countries add an important element to this framework. Here, the adverse effects of a large government are offset by the high efficiency of their public sectors (Oto-Peralías and Romero-Ávila, 2013), which is attributed to strong civic capital — a key factor that helps curb free-riding among citizens and misconduct among officials (Bergh and Bjørnskov, 2011).[2]

While civic capital is undoubtedly important, it remains unclear why these countries manage to successfully combine large governments with strong economic performance. Standard models—such as Barro's (1990)—do not offer sufficient detail for examining the interplay between civic capital and government size, particularly in terms of how it affects the latter's optimal level. For instance, modifying Barro's model to incorporate a parameter for civic capital's effect on economic performance does yield

[1] Forte and Magazzino (2014) confirm the so called B.A.R.S. curve, and find that most advanced economies exceed the optimal level.

[2] Civic capital refers to "those persistent and shared beliefs and values that help a group overcome the free rider problem in the pursuit of socially valuable activities" (Guiso et al., 2006). A key component of civic capital is trust in others: when trust is high, individuals believe that reporting misconduct will receive support from the community. On the high level of trust in Scandinavian countries see Thakur et al. (2003), and Svendsen and Svendsen (2016). See also Algan, Cahuc, and Sangnier (2016); Fournier e Johansson (2016); Oto-Peralías, D. and Romero-Ávila (2013).

a positive economic impact, but it leaves the optimal government size unchanged. As a result, the same government size would theoretically apply even in countries with markedly different levels of civic capital. This outcome appears more as a byproduct of the model's initial assumptions than a robust theoretical finding, raising the question of how a more detailed public sector model might alter this relationship.

To develop an analytical framework better suited to studying the mechanisms that govern how civic capital affects economic performance—particularly regarding the optimal size of government—in this paper we provide a more detailed description of how the public sector functions.

As a starting point, we go beyond the common assumption in previous models that the public sector flawlessly converts tax revenues into productive factors, ignoring costs and inefficiencies.[3] This overlooks cross-country differences in public sector quality, which are often disregarded or absorbed into total factor productivity or country fixed effects. Instead, we explicitly model it, considering bureaucracy as a complex interplay of processes that operates through a sequence of highly complementary tasks—a characteristic emphasized as early as the 1970s by Pressman and Wildavsky (1973).

To this end, we draw on Kremer's (1993) O-ring theory. In Kremer's model, a firm's production process consists of multiple tasks, where a single error can significantly reduce the overall value of the sequence. We argue that this framework is particularly well-suited for modeling bureaucratic processes, where even one mistake, arbitrary decision, or inaction by public officials can result in lost investments, delayed grants, or underutilized public resources—ultimately lowering economic productivity.

In our model, the probability of making mistakes or engaging in malfeasance during bureaucratic tasks depends on the country's level of civic capital. This relationship is driven by two key factors. First, merit-based selection and promotion—essential for an effective bureaucracy (Weber, 1922)—are weaker in low-trust societies. Second, in low-trust environments, bureaucrats operate within a society where free-riding is more tolerated and accountability less stringent. As a result, public sector productivity is positively influenced by the level of civic capital.

[3] See Mauro and Pigliaru (2024) for a discussion on this assumption and the relevant literature.

Formally, our model describes a public sector that delivers services using labor and O-ring technology, within an exogenous-growth framework based on Barro (1990).[4] The factors of production include private capital—which encompasses human capital and drives economic growth—and a fixed supply of labor. Workers can move freely between the public and private sectors, resulting in equal wages across both. The government's revenue, obtained from a chosen tax rate, is entirely spent on paying the wages of public workers who provide services to the economy. With the wage bill determined by labor market equilibrium and the government budget defined by the tax rate, the allocation of total labor between the public and private sectors is obtained.

Our model provides a broad perspective on how civicness shapes economic performance. As in Barro (1990), an increase in civic capital shifts the entire inverted U-shaped function upward. However, our main analytical contribution is that higher civicness shifts the curve to the right—that is, our model introduces a previously unexamined mechanism that explains how civicness simultaneously improves public sector efficiency and expands its optimal scale. Thus, our framework assigns a more prominent role to civic capital in shaping the relationship between government size and economic performance than earlier models have suggested.[5]

We test these implications using a panel dataset of 23 OECD countries from 1975 to 2010. Our empirical strategy aims to detect both the inverted-U relationship described above and, crucially, the influence of civic capital on the optimal government size. In line with our theoretical setup, we estimate a dynamic panel data model via system GMM. Both hypotheses receive support from our econometric results. Specifically, we find that the marginal effect of government size decreases linearly and reaches zero at higher thresholds as civicness rises. This marginal effect is positive

---

[4] Our model adapts Barro's (1990) endogenous growth framework to an exogenous growth setting. This choice is driven by the need to clearly define the analytical foundations of much of the empirical evidence, which relies on conditional convergence models toward stationary differences in per capita GDP. For a recent example of an endogenous growth model examining the determinants and effects of government size, see Arawatari et al. (2023).

[5] Arora and Chong (2018) find that high institutional quality leads to a smaller informal sector, implying a larger formal sector and higher optimal tax rates. Unlike us, however, they do not model how civicness enhances government efficiency and supports a larger optimal public sector.

and statistically significant for tax rates below 28.8% at the lower end of the civicness range, and below 34.6% at its higher end.

Our paper builds upon two strands of research on the relationship between trust, government size, and economic performance. The first strand posits that high civic capital promotes growth, as it is generally associated with lower transaction costs, less corruption, reduced free-riding, and other forms of resource waste (Knack and Keefer, 1997; Knack, 2002; among others). These studies connect to the extensive literature on social capital and economic performance initiated by Putnam (1993) and summarized in Guiso et al. (2006).

The second strand focuses on the mechanisms by which a high sense of civic duty fosters public action that enhances economic performance. Nannestad (2008) suggests that high civic capital sustains universal welfare systems by preventing widespread free-riding. Aghion et al. (2010) argue that low trust leads to high demand for regulation in contexts where officials are prone to wrongdoing, resulting in negative impacts of public action on economic performance. Our work adds to this framework by proposing a novel hypothesis on bureaucracy functioning, enabling measurement of the effects of wrongdoing associated with low civic sense on public sector productivity and economic growth.

Furthermore, our research helps interpret findings from empirical studies estimating the optimal government size across countries. For instance, DeWitte and Moesen (2010) estimate that the optimal government size varies significantly across nations, contrary to other studies' assumptions, with the highest levels in Scandinavian countries. In our model, countries with different fundamentals—civicness in our case—have different optimal government sizes, providing a possible explanation for this empirical evidence.

Finally, our model also demonstrates that Kremer's O-ring theory can be applied to an additional context not yet analyzed from this perspective: the public sector and the determinants of its efficiency.

The paper is structured as follows. Section 2 presents the analytical setup upon which our theory is built (2.1), introduces and explains the use of Kremer’s O-ring theory as applied to the public sector (2.2), and describes our modeling of the entire economy and its dynamics. Section 3 describes the empirical strategy we adopt to test the proposed theoretical mechanism, and discusses the econometric findings. Section 4 concludes.

2 The Model

Before presenting our model, we briefly summarize the analytical framework that underpins our contribution. This is instrumental in better clarifying how our analysis and its resulting findings diverge from prior studies.

2.1 Analytical background

Our model fits within the analytical context of Barro's (1990) contribution. As mentioned in the Introduction, much of the empirical evidence cited there utilizes the analysis of conditional convergence, where the size of the government (or the level of taxation) determines a country's steady state. The basis of this approach is the exogenous growth version of Barro's model, i.e. $Y = AL^{1-\alpha}K^{\alpha}G^{\beta}$, where Y is total output, A is an index of total factor productivity, L and K are labour and capital, and G is the public sector expenditures.[6] In this economy $\alpha + \beta < 1$ makes growth exogenous, and the public sector's activity must satisfy a balanced-budget constraint, namely $G = \tau Y$ where τ is the average tax rate as well as the index of government size. This model generates an inverted U-shaped relationship between the steady-state levels of Y^* and τ. Beyond the implicit optimal level, the effect of government size becomes negative, consistent with empirical evidence in developed countries.

However, because this model represents the public sector in an extremely simplified manner, it does not allow for a satisfactory analysis of how social capital influences the optimal level of government. One common way to incorporate civic capital into the model with only minor structural modifications, is to introduce an efficiency parameter (ω), increasing with civic capital, which enters multiplicatively into the production function, namely $Y = AL^{1-\alpha}K^{\alpha}(\omega G)^{\beta}$. Higher values of ω shift the entire function upward. Since the production function can be rewritten as $\hat{A}L^{1-\alpha}K^{\alpha}G^{\beta}$, where $\hat{A} = A\omega^{\beta}$, we see that this upward shift in the Y^*-government size relationship

[6] It is well known that in Barro's endogenous growth model the assumption $\beta = 1 - \alpha$ implies an AK type growth model.

leaves the optimal size of the government unchanged. As noticed earlier, this outcome appears more as a byproduct of the model's initial assumptions than a robust analytical finding.[7]

In summary, merely incorporating civicness as an additional or altered parameter in the Barro model tends to yield hard-to-interpret results that fail to capture the specific, well-defined mechanisms driving the link between civicness and higher government efficiency.

In the next section we propose incorporating a dedicated theoretical framework, based on Kremer (1993), that explicitly formalizes how civicness enhances public-sector productivity. This approach completes the analytical structure without reducing it to simple parametric adjustments, ultimately yielding more coherent and robust findings.

2.2 O-ring theory and public sector efficiency

In the following, we first describe the public sector and then we incorporate it in the production function of our model economy.

We characterize the functioning of the public sector by means of the O-ring theory developed by Kremer (1993). The O-ring theory addresses "processes made of a series of tasks, mistakes in any of which can dramatically reduce the (…) value" of the whole sequence (Kremer, 1993, p. 551). We argue that this strong complementarity across tasks is particularly well-suited for modelling bureaucratic processes, where even a single error or arbitrary decision or inaction by public officials can lead to lost investments, delayed grants, or underutilized public resources, ultimately reducing the economy's overall productivity.

Formally, the public sector is assumed to provide a flow of productive public service, P. This flow of service is the output of a series of bureaucratic tasks accomplished by labor inelastically supplied by L_g public servants.

[7] A second possible approach is to allow the parameter β to depend on civic capital. While higher values of β increase the optimal size of government, this approach still fails to shed light on the underlying mechanisms driving this outcome.

The way tasks are carried out is influenced by factors that shape the quality with which public servants fulfil their duties. As in Kremer, a public servant's quality (q) at a task "is defined by the expected percentage of maximum value the product retains if the worker performs the task" (p. 553). We'll discuss below how this quality is determined.

We assume the number of tasks n to be a linear function of L_g , namely $n = \vartheta \cdot L_g$. Moreover, we assume q_i to be the average quality of the public servants engaged in the i-th task and, likewise Kremer (1993),[8] the tasks to be independent. Therefore, the expected public sector output per public servant P/L_g is:

(1) $P/L_g = B \prod_1^n q_i$

where B can be thought as the maximum output per public servant when all tasks are performed spotlessly, i.e. $q_i = 1$ for all tasks.

Consistently with Kremer's original idea, this formulation implies strong cross-task complementarity. If just one task is not accomplished ($q_i = 0$), total output drops to zero. More generally, even a slight drop in one q_i has a large aggregate effect.

Being an expected percentage of the maximum value B, q can be interpreted as the probability of obtaining that maximum value by a worker allocated to a task.

The value of q can reflect various underlying factors. In Kremer's analysis of private firms, q represents individual skills, which are, in turn, determined by human capital. Here, we shift our focus from human to civic capital—a social phenomenon that shapes the behavior of public servants. Several factors justify this approach. First, merit-based selection and promotion—essential for an effective bureaucracy (Weber, 1922)—are weaker in low-trust societies. Second, in low-trust environments, bureaucrats operate in a context where free-riding is more tolerated and accountability is less stringent (Guiso et al., 2006). As a result, public servants' quality-adjusted productivity is positively influenced by civic capital. When civic

[8] In Kremer (1993), the O-ring technology refers to a generic i-th firm endowed with capital k_i, assuming—conveniently but not necessarily—that the number of tasks and workers coincide. Kremer initially introduces the O-ring technology formally as: $y_i = {k_i}^{\alpha}\, n_i\, B \prod_1^{n_i} q_i$. Clearly, the per worker average productivity is: $\bar{y}_i = {k_i}^{\alpha} B \prod_1^{n_i} q_i$.

capital is low, misconduct and inefficiency become more widespread, undermining the effectiveness of public administration (Putnam,1993; Helliwell and Putnam,1995).

We assume a one-to-one relationship between social capital understood as civicness and q, the probability to rightly complete one task. In addition, the level of civic capital, and therefore of q, is the same across all public servants and tasks. Under this assumption we can simplify eq. (1) to get the following specification close to Kremer's (1993) for the total public sector output:

(2) $$P = L_g\, Bq^{\vartheta L_g}.$$

Figure 1 shows how P increases as q moves from zero to one for two values of L_g.[9] Two aspects are worth noticing. First, small differences in q may generate large differences in P, consistently with Kremer's key hypothesis. Second, as L_g increases, the probability that at least one task is performed inappropriately rises, leading to significant aggregate damage. Consequently, with a low level of q, better results are achieved with a reduced number of tasks (and of public servants). To benefit from more complex techniques, involving a greater number of tasks, it is essential for q to be high. As we will see presently, in our economy L_g is determined endogenously.

Before moving on to the model analysis, we subject a key implication of O-ring theory to a preliminary test, verifying whether it holds in our reference countries (the OECD). Specifically, for the O-ring mechanism to be valid, the exponent of q in equation (2) must exceed one. This test can be performed in two ways. First, an empirical implication of this condition is that the coefficient of variation of P is higher than that of civic capital for almost any distribution over countries of q. Second, in a cross-country regression of *ln(P)* on *ln(q)*, the coefficient of the latter is expected to be greater than one.

We use *Trust* as our proxy for q and – in the absence of data on public sector output – an index of *Government Effectiveness* for P.[10] If the data showed a coefficient of

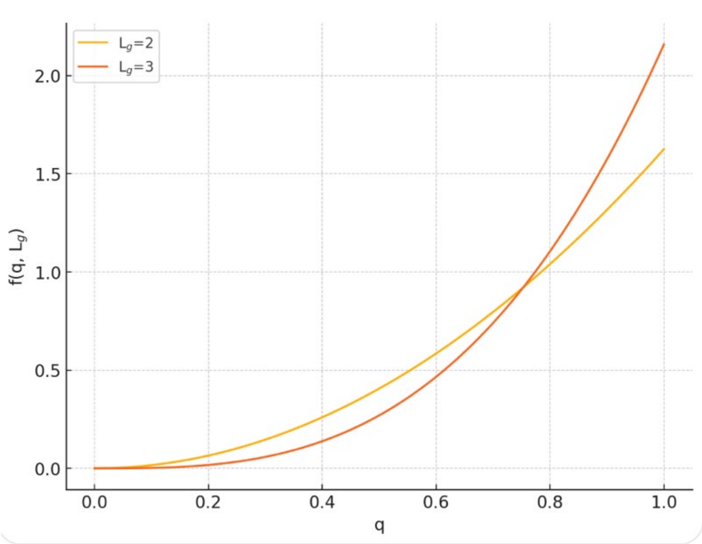
---

[9] The L_g values are 2 and 3, $B = 1$ and $\vartheta = 1$.

[10] The 35 countries used in our calculations are: Australia, Austria, Belgium, Canada, Chile, Colombia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovenia, Spain, Sweden,

variation (CV) of government effectiveness lower than that of trust, it would imply an exponent of q less than 1, thereby calling into question the validity of the Kremer-inspired approach. In contrast, the available data confirm the model's prediction: the coefficient of variation for trust stands at 44.6%, while that for government effectiveness reaches 47.6%. Moreover, the estimated elasticity of government efficiency with respect to trust is equal to 1.24 and significant at the 1% level.[11] This outcome is consistent with the Kremer approach adopted in this paper.

Figure 1: *P as a function of q*



2.3 The economy at large

Our stylized economy is assumed to be populated by a constant number L of infinitely lived households. Some of them, L_p, work in the private sector characterized by a large number of firms equal to M. The firms are identical, and output is produced in a competitive setup, taking the public sector flow of service P as given, along with A, the technological parameter. The individual firm's technology is:

Switzerland, Turkey, United Kingdom and United States. The data on *Trust* ("Most people can be trusted"; see Section 3 below for more details) and *Government Effectiveness* are from the database *Our World in Data* (https://ourworldindata.org/). We have computed the average values of the two variables using all the available annual entries present in the database for each country.

[11] Since Colombia's index of government efficiency was negative, the reported elasticity was estimated after excluding this country. Even in this restricted sample, the coefficient of variation (CV) for government efficiency remains higher than that for trust.

(3) $y_i = A\, k_i^{\alpha} l_{p,i}^{1-\alpha} P^{\gamma}$

where y_i , k_i and $l_{p,i}$ are the i-th firm output, capital and labour. As seen above, the main analytical approach used to guide the existing empirical studies of the role of government size is based on diminishing returns and exogenous growth. Our model follows this line of thought, i.e. $\alpha + \gamma < 1$.

Firms' profit maximization requires that the standard conditions for capital and labour hold:

(4) $w = (1-\alpha) A\, k^{\alpha} l_p^{-\alpha} P^{\gamma}$

(5) $r = \alpha A\, k^{\alpha-1} l_p^{1-\alpha} P^{\gamma} - \delta$

where the subscript i for simplicity is ignored and w and r are, respectively, real wage and real capital return net of depreciation.

The aggregate production function of this economy is: [12]

(6) $Y = AK^{\alpha} L_p^{\,1-\alpha} P^{\gamma}$

With full employment:

(7) $L = L_p + L_g$

where L_g is the labour force allocated to the public sector.

Labour is fully mobile across sectors, so the government pays the public servants the same wage as the private sector. Then, the balanced budget constraint is:

(8) $\tau Y = (1-\tau)\, w\, L_g$

where τ is the average tax rate as well as our measure of government size. Using this condition and the firms' optimality condition in equation (4) one gets:

(9) $\tau = (1-\alpha)(1-\tau)\, L_g/(L-L_g)$.

[12] Since all the firms are identical it follows that: $y = \frac{Y}{M} = A\left(\frac{K}{M}\right)^{\alpha}\left(\frac{L_p}{M}\right)^{1-\alpha} P^{\gamma}$, with $l_p = \frac{L_p}{M}$ and $k = \frac{K}{M}$ and it is trivial to obtain the aggregate output.

So, L_g can be expressed as a function of τ:

(10) $L_g = \frac{\tau L}{1-\alpha(1-\tau)}$

Once a given tax rate is chosen by the government, the number of public servants (and tasks) is determined using equation (10). For each possible value of τ, we can rewrite the production function in eq. (6) by replacing L_p with $L - L_g$, and L_g with $\frac{\tau L}{1-\alpha(1-\tau)}$. So, we now have

(11) $Y = AK^{\alpha}Z$

where $Z = \left(L - \frac{L\tau}{1-\alpha(1-\tau)}\right)^{1-\alpha} \left(\frac{L\tau}{1-\alpha(1-\tau)}\right)^{\gamma} B^{\gamma} \left(q^{\frac{\vartheta L\tau}{1-\alpha(1-\tau)}}\right)^{\gamma}$

Our next step is to study how the steady-state values of Y vary as the tax rate changes. To this aim we first need to study the stability of the dynamic equilibrium of the system and how the steady-state values of K are determined for any given value of the tax rate.

We assume that the households solve an inter-temporal maximization problem where preferences are described by a standard iso-elastic utility function of consumption c. The problem can be summarized as:

(12) $Max \int_0^{\infty} \frac{1}{1-\theta} c(t)^{1-\theta} e^{-\rho t}\, dt$

subject to:

(13) $\dot{a} = (1-\tau)(r\,a + w) - c$

(14) $\lim_{t\to\infty} a(t)e^{-r\,t} = 0$

where ρ is the household discount rate, θ the inverse of the elasticity of substitution and a is the financial asset. The solution of the problem yields the usual Euler condition for each household:

(15) $\frac{\dot{c}}{c} = \frac{1}{\theta}\big((1-\tau)r - \rho\big)$,

where $(1-\tau)r$ is the after-tax rate of return and r is defined by equation (5) .

Since $a = k = K/L$, the law of motion for k is:

(16) $\dot{k} = (1-\tau)(r\,k + w) - c$

Substituting w and r from (4) and (5) and using equation (10) after some algebra we get the growth rate of per capita private capital as well as the aggregate capital since L is constant:

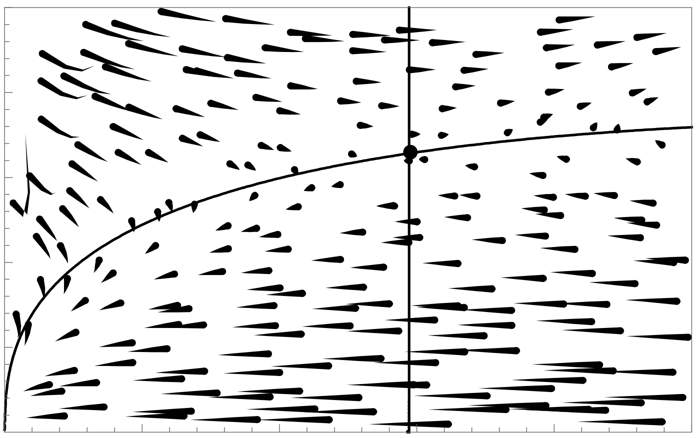
(17) $\frac{\dot{k}}{k} = \frac{\dot{K}}{K} = AK^{\alpha-1}Z - (1-\tau)\delta - \frac{C}{K}$

In the same fashion from equations (5) and (15) we obtain:

(18) $\frac{\dot{c}}{c} = \frac{\dot{C}}{C} = \theta^{-1}[(1-\tau)\alpha AK^{\alpha-1}Z - (1-\tau)\delta - \rho]$

Therefore, the entire dynamics of the economy can be summarized by the two differential equations of the model, (17) and (18). We numerically analyze these dynamics using a phase diagram in *C* and *K*, as shown in Figure 2. This figure presents the phase diagram generated in *Mathematica*[13] using parameter values commonly adopted in the calibration literature (e.g., Mauro et al., 2023).[14]

Figure 2: *Phase diagram*



[13] We use Mathematica 14 and the package VisualDSolve to numerically depict the phase diagram and to obtain the eigenvalues.

[14] The values are: $\alpha = 0.4$, $\vartheta = 0.5$, $\gamma = 0.2$, $L = 10$, $q = 0.4$, $\rho = 0.02$, $\theta = 2.5$, $\delta = 0.05$, $\tau = 0.3$, A=100, B=44. The eigen values are 0.05 and -0.02 implying saddle point stability.

Given the initial condition *K(0)*, once the government sets the tax rate the economy converges toward a steady state, as the system's eigenvalues have opposite signs, implying saddle-point stability.[15] This entitles us to analyze the steady state relationship between aggregate income and τ.

From the Euler equation we obtain the steady state value of aggregate capital:

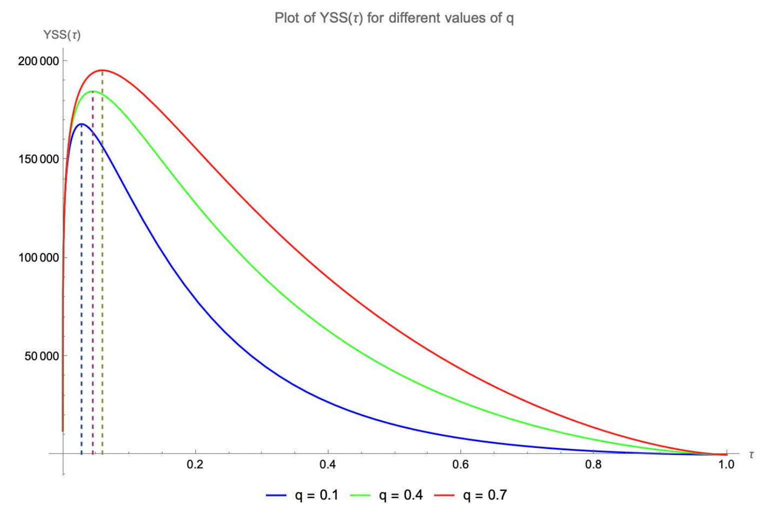
$$(19) \quad K^* = \left(\frac{A\,\alpha(1-\tau)}{(1-\tau)\delta+\rho}\right)^{\frac{1}{1-\alpha}} Z^{\frac{1}{1-\alpha}}$$

Substituting K by K^* in eq. (11) and simplifying, we obtain the formula for the steady state value of Y as a function of τ and the other parameters of the model:

$$(20) \quad Y^* = \left(\frac{\alpha(1-\tau)}{(1-\tau)\delta+\rho}\right)^{\frac{\alpha}{1-\alpha}} (AZ)^{\frac{1}{1-\alpha}}$$

The relationship between Y^* and τ defined by equation (20) can now be analyzed. The relationship, shown in Figure 3, confirms the inverted-U pattern typical of the models derived from the Barro (1990) approach.[16]

Figure 3: *Inverted U*



[15] The system remains saddle point stable under a range of values for τ (0.0-0.9) and q (0.1-0.9) while we keep the other parameters fixed at the formerly defined levels.

[16] The parameter values are the same as defined in note 14.

More important is the analysis of how changes in civic capital, and consequently in q, on the $Y^* - \tau$ relationship. As shown again in Figure 3, an increase in q shifts the curve upward *and* to the right.

As for the first effect, the upward shift, it suggests that civicness mitigates the negative effects of large governments: economies in countries with higher levels of civicness benefit from larger governments. In a sense, 'bumblebee countries' can fly because their high civicness enhances the efficiency of their formal institutions. This finding aligns with prior research, such as Bergh and Bjørnskov (2020).

However, our results extend beyond this by demonstrating a second effect of higher civicness. The rightward shift of the function indicates that integrating O-ring technology into a Barro-style growth model assigns civic capital an additional positive role: not only does it increase income levels, but it also raises the optimal size of government. In a nutshell, our model assigns a broader role to civic capital in shaping economic performance than previous models in the Solow[17] or Barro (1990) tradition.

3 Testing the model predictions.

Let us summarize the main predictions of our model. First, following the approach initiated with Barro (1990), as τ increases starting from low levels, output Y^* initially rises but eventually declines, generating an interior maximum (τ_{max}). Second, unlike models in which civicness simply augments total factor productivity—thereby shifting the output–tax curve upward without altering τ_{max}, (see section 2.1)—our specification includes an interaction term between civic capital and τ (this condition can be deduced by transforming equation (20) that contains Z into logarithms). This interaction term implies that, in high-trust contexts, the tax rate that maximizes Y^* is higher. So, in our model civic capital not only shifts the curve upward but also changes τ_{max}.

[17] See for instance Chu (2006), where trust acts as a direct or indirect multiplicative input.

3.1 Empirical Strategy.

The above implications are tested using a panel data set of 23 OECD countries during the period 1975-2010 (see below for details on the dataset).[18] We estimate the following general dynamic panel data model, without imposing the condition that per capita GDP is always along its steady-state path:

$$(21)\quad lny_{it} = \gamma_i + \lambda_t + a_1 lny_{it-1} + a_2\tau_{it} + a_3\tau^2{}_{it} + a_4 q_{it} + +a_5(q_{it} * \tau_{it}) + X'_{it}\beta + \varepsilon_{it},$$

$$\text{for } i = 1, \dots, N; t = 1, \dots, T.$$

where y_{it} is the real per capita GDP; τ_{it} is the share of government revenues over GDP, our proxy for government size; q_{it} is the log of our proxy for civic capital, an index of "trust" based on various WVS; γ_i and λ_t are country and time fixed effects, respectively; ε_{it} is an idiosyncratic disturbance term; and X_{it} is a vector of covariates.

In this model, $a_2 > 0$ and $a_3 < 0$ would support the hypothesis of an inverted-U path. Besides, if trust raises τ_{max}, the interaction coefficient a_5 should be positive and statistically significant. In such a case, we would have evidence confirming that the marginal effect of taxation on output becomes more favorable in high-trust environments, thereby shifting the inverse-U curve to the right and increasing τ_{max}, consistent with our theoretical framework.

3.2 Data.

Annual data on the real per capita GDP for the 23 OECD countries are taken from the Penn World Table 7.1.[19] Regarding civic capital, following a common practice in the social capital literature, we use trust as a proxy for civicness. To construct our measure of trust, we use the percentage of respondents at the regional level who answered, "Most people can be trusted" [20] to question a165 of Integrated Values

[18] The countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece , Hungary, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.

[19] In particular the income is the variable Rgdpch that is converted GDP Per Capita (Chain Series), at 2005 constant prices in PPP taken from Penn World Table 7.1 (Heston et al.,2012).

[20] The data are attributed to regions on the base of the crossing variable X048-Region, where the interview was conducted. Every region is then associated to the corresponding one in the standard international classifications: NUTS for Europe and OECD TL for non-European nations.

Surveys. Then, the national average of the civic-capital endowment, Trustpop, is obtained by weighting regional trust of the country with the average regional share of the national population in the period considered[21], and transforming it in non-percentage points. Our calculations are based on data from the Integrated Values Surveys (EVS, 2011; WVS, 2009), including all available waves and attributing them to the nearest five-year period of our analysis.

As measure of government size, we use the share of total tax revenues over GDP (Tax_tot), taken from OECD Fiscal Decentralization Database.

We also considered some standard conditioning variables in growth regressions, such as the investment share, the degree of openness, the investment in secondary education and population growth, but they were never significant in all models. This result is far from unexpected since the data set is composed of advanced OECD countries. So, we dropped those regressors from the model and in the estimates listed below, to save space, we reported the models estimated without such conditioning variables.

3.3 Results.

We utilize an unbalanced panel of quinquennial data, which as written above includes 23 countries observed in the time-period 1975-2010. To estimate the model, we apply the system GMM estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998), which has come to represent the standard approach to estimating dynamic growth models on five-year averaged cross-country data. With a suitable choice of instruments, this approach permits us not only to get rid of country fixed effects, but also to consider potential endogeneity of some of the covariates. The system GMM estimator allows us to efficiently combine information from the equations in levels with the set of orthogonality conditions holding for the equations in first differences. In so doing, it is possible to retain part of the between-countries variation while also controlling for country heterogeneity.[22] Following the logic of

---

[21] The way we calculated the national average, Trustpop, has the side effect of increasing the time variability of trust, which is quite stable over time, as it is supposed to be.

[22] Due to persistence of the variables over time, Bond et al. (2001) show that the first-differenced GMM estimator performs poorly, whereas the system GMM estimator gives more reasonable results when applied to an empirical growth model.

system GMM, we use the second and third lags of the endogenous regressors and of the dependent variable in levels as instruments for the equations in first differences to be estimated; and we use the first lag of the same variables in first differences as instruments for the equations in levels. Time fixed effects are included in all models but not reported. We apply the one-step system GMM estimator, using standard errors robust to heteroscedasticity.[23]

The main results of the analyses are shown in Table 1. In column (1) of the Table, we report the estimation results of our model, which, consistent with the theoretical implications presented in the previous sections, controls for the log of trust (ln Trustpop), the government size proxy (Tax_tot) and its square (Tax_tot^2) as well as the interaction between government size and civic capital (ln Trustpop*Tax_tot). At the bottom of column (1), we report some statistical tests for the validity of instruments: the Sargan's test of over-identifying restrictions (not robust to heteroscedasticity, but not weakened by many instruments), the Hansen's test of over-identifying restrictions, computed from two-step System GMM estimates, and the Arellano's panel autocorrelation tests computed from residuals of the model equation in first differences. Looking at the results of such tests, we can see that the instruments validity is not rejected at the 5% significance level.

Importantly, our estimates reveal a clear inverted-U relationship between income and government size, as well as a positive effect of trust on the latter's optimal level. This is evident from the signs of the estimated coefficients of civic capital and the interaction term—specifically, $a_2 > 0$, $a_3 < 0$ and $a_3 > 0$ in equation (21). These signs align with our theoretical expectations.

[23] It is well known that the two-step GMM estimates present asymptotic standard errors that are severely downward-biased in small samples.

Table 1: *Dependent Variable log of real per capita GDP*

	(1)	(2)	(3)
ln y_1	0.911***	0.912***	0.908***
	(0.0285)	(0.0250)	(0.0257)
ln Trustpop	0. 012		0.058***
	(0.1180)		(0.0207)
Tax_tot	3.341**	3.452***	2.104*
	(1.6621)	(1.1790)	(1.1271)
Tax_tot^2	-4.561**	-4.673***	-3.050***
	(2.0056)	(1.5835)	(1.5369)
ln Trustpop*Tax_tot	0.129	0.161***	
	(0.3264)	(0.0528)	
Const	0.412	0.377	0.684*
	(0.5368)	(0.3534)	(0.3786)
Obs	134	134	134
Groups	23	23	23
AR(1)	-2.49**	-2.49**	-2.44**
AR(2)	0.55	0.55	0.50
Sargan[a1]	84.67*	84.61*	66.99*
Hansen[a2]	14.82	15.62	14.74
Wald's test[b]: $\chi^2(2)$	10.54***		
Wald's test[c]: $\chi^2(2)$			6.18**

Notes: standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

[a1] Computed from one-step system GMM estimates.

[a2] Computed from two-step system GMM estimates.

[b] The null hypothesis is that ln Trustpop and ln Trustpop*Tax_tot are jointly not relevant.

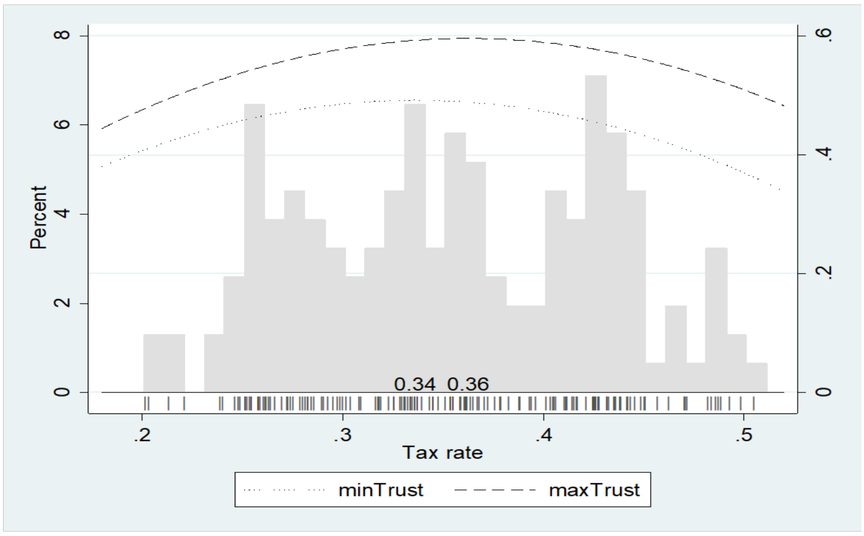
[c] The null hypothesis is that Tax_tot and Tax_tot^2 are jointly not relevant.

Those features can be verified also graphically from inspection of Figure 4, where two inverted-U curves, corresponding to the estimated function

$$(22)\quad g(lnTrustpop, Tax_{tot}) = \hat{\beta}_1 lnTrustpop + \hat{\beta}_2 Tax_{tot} + \hat{\beta}_3 Tax_{tot}^2 + \hat{\beta}_4 lnTrustpop \cdot Tax_{tot}$$

are plotted over the range of sample values of Tax_tot, for Trustpop equals to, respectively, its minimum (0.12, Portugal in 2000-2005) and maximum value (0.76, Denmark in 2005-2010) in the sample. The graph also includes information about the distribution of Tax_tot (left scale) and its rug plot. In line with the theory, a higher trust implies a higher value of the function for any level of government size. Moreover, the higher the civic capital is, the higher the government size maximizing the output: 36% vs. 34% in this case.

Figure 4: *Inverted U given trust*



Returning now to the estimation results of our model reported in Table 1, we notice that while the Wald's tests taken separately signal that regressors ln Trustpop and ln Trustpop*Tax_tot are not significant at 10% level, the Wald's test reported at the bottom of column (1) rejects the joint null hypothesis at the 5% level, casting some doubts on reliability of the marginal Wald's tests, probably a consequence of collinearity between regressors. Therefore, to try to ascertain the existence of an imperfect collinearity problem, as customary in these cases we report in columns (2) and (3) of Table 1 the estimation results of the model where regressors ln Trustpop or ln Trustpop*Tax_tot have been removed.[24]

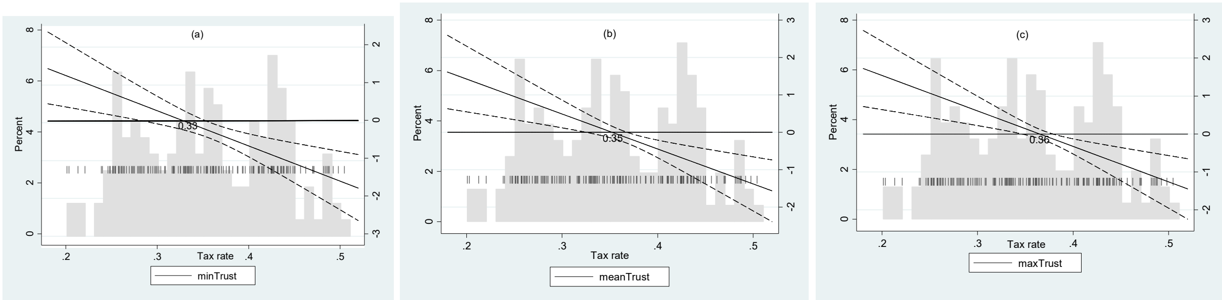
As expected, now the interaction term in model (2) turns out to be highly significant, and the same result is obtained in model (3) for trust. These results taken together support the view that both regressors are relevant for explaining the growth of the analyzed OECD countries. However, it's interesting to notice that in model (2) the magnitude of the estimated coefficients, relative to regressors Tax_tot, Tax_tot^2 and ln Trustpop*Tax_tot, is very similar to that of model (1), but standard errors turn out to be much lower. Instead in model (3), the reduction in standard errors is accompanied by a large downward bias (in absolute value) of the estimated coefficients relating to the size of government (and its square). Therefore, to improve the precision in estimating the effects of the size of government on income for different levels of civic capital endowment, it's preferable to base such analyses on the estimation results of model (2).

In Figure 5 we show the graph of the estimated partial derivative of log per capita GDP with respect to government size, for three different levels of ln Trustpop in the sample: respectively, the minimum (minTrust) in panel (a), the mean (meanTrust) in panel (b) and the maximum (maxTrust) in panel (c). In addition, the graphs show the 90% confidence bands and the value of government size for which the estimated marginal effect on income is null. In line with the results presented above using the estimates from model (1), the marginal effect of government size decreases linearly and becomes zero for values that increase as the level of country's trust considered increases. Moreover, the marginal effect is positive and statistically significant at 10% for values of the tax rate lower than 28.8% in panel (a), lower than 32.5% in panel (b) and lower than 34,6% in panel (c).[25]

24 To make the model comparison invariant to the set of instruments, we estimated model (2) using the same instruments of model (1). Instead in model (3) we removed the instruments of the excluded regressor (the interaction term) because the model is linear in trust and thus it doesn't make sense to use such extra non-linear instruments.

25 These results are in line with Fournier and Johansson (2016) and Dong-Hyeon et al. (2018) who interact government size proxy with indicators of government effectiveness. They are also in line with Bergh and Bjørnskov (2020) who find a minor negative effect of large government size in high trust countries.

Figure 5: *Partial derivative of Output w.r.t. Tax rate given trust*



Overall, our findings corroborate the main analytical result of our model: countries with higher levels of civicness can sustain larger optimal public sectors without undermining economic growth. This observation underscores how institutional quality, grounded in social trust, plays a pivotal role in conditioning the relationship between government size and economic performance.

Conclusions

This paper has explored how civic capital modifies the relationship between government size and economic performance. Our theoretical contribution extends the Barro (1990) framework by incorporating Kremer's (1993) O-ring theory into the analysis of the public sector. This integration provides a clearer understanding of how civicness—rooted in social trust and cooperative norms—enhances bureaucratic efficiency by reducing errors and malfeasance in public administration. We demonstrate that higher civic capital not only shifts the conventional inverted-U relationship between government size and economic output upward, but also rightward, thereby increasing the optimal size of government. In other words, countries endowed with greater civicness can sustain larger public sectors without compromising economic performances.

Empirical tests using a dynamic panel data model for 23 OECD countries (1975–2010) corroborate these theoretical predictions. Our results confirm both the inverted-U relationship and the moderating role of civic capital, as measured by trust. Our estimates indicate that the marginal effect of government size becomes zero at higher tax rates for more civic countries. This supports the notion that institutional quality, rooted in social trust, can offset many of the negative consequences typically associated with a large public sector. These findings help reconcile why highly civic nations, such as those in Scandinavia, often exhibit strong economic performance despite relatively high levels of taxation and public spending.

Looking ahead, our analysis suggests several promising avenues for further research. First, because our model treats the tax rate as exogenous, a natural extension would be to incorporate political-economy mechanisms that endogenize the tax rate, along the lines of Persson and Tabellini (2000). This would allow for a deeper exploration of how political incentives and voter preferences interact with civic capital to shape fiscal policy. Second, it would be valuable to investigate how the O-ring interaction between civicness and broader institutional features—such as legal frameworks and governance structures—contributes to the extensive literature on comparative advantage (Acemoglu et al., 2005). Specifically, future work could examine how cross-country differences in institutional quality influence specialization in sectors with varying degrees of technological complexity (number of tasks). Finally, considering heterogeneity in public spending composition—such as investment in infrastructure versus social transfers—could refine our understanding of which components of a "large government" benefit most from strong civic capital). For instance, does civic capital enhance the efficiency of infrastructure investments more than social welfare programs, or vice versa? This would align with recent works (Alesina et al., 2019), who highlight the importance of spending composition for growth outcomes.

Together, these directions underscore the value of integrating civic capital and complementary bureaucratic processes into studies of state size and economic performance. By doing so, researchers and policymakers can better understand how institutional and cultural factors shape the effectiveness of public sector expansion, offering new insights into the design of policies that promote sustainable economic growth.

References

Acemoglu, D., Johnson, S., & Robinson, J. A. (2005). Institutions as a Fundamental Cause of Long-Run Growth. *Handbook of Economic Growth*, 1A, 385-472.

Alesina, A., Favero, C., & Giavazzi, F. (2019). *Austerity: When It Works and When It Doesn't*. Princeton University Press.

Arawatari R., Hori T. and Mino K., (2023) Government expenditure and economic growth: A heterogeneous-agents approach, Journal of Macroeconomics, Volume 75, 2023,103486,ISSN 0164-0704, https://doi.org/10.1016/j.jmacro.2022.103486.

Afonso A., Schuknecht L., Tanzi V., (2002), Public Sector Efficiency: An International Comparison, European Central Bank Working Paper, 242.

Afonso, Antonio, and Davide Furceri.(2010) Government Size, Composition, Volatility and Economic Growth. European Journal of Political Economy 26 (4), 517–532.

Aghion, P., Algan, Y., Cahuc, P., Shleifer, A., 2010, Regulation and Distrust, Quarterly Journal of Economics, 125(3): 1015–1049.

Arellano M. and Bover O. (1995), Another look at the instrumental variable estimation of error-components models, Journal of Econometrics, 68, 29-51

Armey D. and Armey R. (1995). "The Freedom Revolution: The New Republican House Majority Leader Tells Why Big Government Failed, Why Freedom Works, and How We Will Rebuild America, Washington, D.C.; Regnery Publishing Inc. .

Algan Y. ,Cahuc P. and Sangnier M., 2016. "Trust and the Welfare State: the Twin Peaks Curve," Economic Journal, Royal Economic Society, vol. 126(593), pages 861-883, June.

Arora P. and Chong A. (2018), Government effectiveness in the provision of public goods: the role of institutional quality, Journal of Applied Economics, 21:1, 175-196

Barro R.J. (1990), Government Spending in a Simple Model of Endogenous Growth , The Journal of Political Economy, 98, 103-125.

Barro, R., & Sala-i-Martin, X. (1995). Economic growth, Cambridge, MA: MIT Press.

Barro, R., & Sala-i-Martin, X. (2003). Economic growth (2nd ed.), Cambridge, MA: MIT Press.

Bergh A. and Bjørnskov C. (2011), Historical Trust Levels Predict Current Welfare State Size. Kyklos 64 (1), 1–19.

Bergh A. and Bjørnskov C., (2020), Does Big Government Hurt Growth Less In High-Trust Countries?, Contemporary Economic Policy, Western Economic Association International, vol. 38(4), pages 643-658, October.

Bergh, A. and Henrekson, M. (2011), Government Size and Growth: a Survey and Interpretation of the Evidence, Journal of Economic Surveys, 25: 872-897.

Bjørnskov C. (2003), Corruption and Social Capital, Aarhus School of Business working papers, 03-13.

Blundell R. and Bond S. (1998), Initial conditions and moment restrictions in dynamic panel-data models, Journal of Econometrics, 87: 115–143.

Bond S., Hoeffler A. and Temple J. (2001), GMM Estimation of Empirical Growth Models, CEPR Discussion Papers, n. 3048, London, UK.

Chou Y. (2006). Three Simple Models of Social Capital and Economic Growth. Journal of Socio-Economics. 35. 889-912. 10.1016/j.socec.2005.11.053.

Christie T. (2014). "The effect of government spending on economic growth: Testing the non-linear hypothesis." Bulletin of Economic Research 66.2 (2014): 183-204.

De Witte K. and Moesen W., (2010), Sizing the government, Public Choice, 145, (1), 39-55

Dong-Hyeon Kim, Yi-Chen Wu, Shu-Chin Lin, (2018) Heterogeneity in the effects of government size and governance on economic growth,Economic Modelling,Volume 68, 2018,Pages 205-216 ISSN 0264-9993

EVS (2011), European Values Study 1981-2008, Longitudinal Data File. GESIS Data Archive, Cologne, Germany, ZA4804 Data File Version 2.0.0 (2011-12-30) DOI:10.4232/1.11005 .

Facchini, F. and Melki, M. (2013). Efficient Government Size: France in the 20th Century.
European Journal of Political Economy, 31, 1-14.

Forte F. and Magazzino C., (2011) , Optimal Size Government and Economic Growth in EU Countries, Economia Politica, Società editrice il Mulino, issue 3, pages 295-322

Fournier, J. and Johansson Å. (2016), “The Effect of the Size and the Mix of Public Spending on Growth and Inequality”, OECD Economics Department Working Papers, No. 1344, OECD Publishing, Paris, https://doi.org/10.1787/f99f6b36-en.

Golden M. and Picci L. (2005), Proposal of a New Measure of Corruption, Illustrated with Italian, Economics and Politics, 17,   37-75.

Guiso L., Sapienza P. and Zingales L. (2010), Civic Capital as the Missing Link, NBER WP, No 15845.

Guiso L., Sapienza P. and Zingales L. (2006). “Does Culture Affect Economic Outcomes?”, Journal of Economic Perspectives (2006) 20: 23-48.

Helliwell J. and Putnam R. (1995), Economic Growth and Social Capital in Italy, Eastern Economic Journal, 21, 295-307

Heston A., Summers R. and Aten B. (2012), Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, (July 2012)

Knack S. (2002), Social capital and the quality of government: evidence from the States, American Journal of Political Science, 46, 772-785.

Knack S. and Keefer P. (1997), 'Does Social Capital Have An Economic Payoff? A Cross-Country Investigation', Quarterly Journal of Economics, vol.112, pp.1251-1288.

Kremer M. (1993), The O-Ring Theory of Economic Development, The Quarterly Journal of Economics, President and Fellows of Harvard College, vol. 108(3), pages 551-575

Witte K. and Moesen W. (2010) "Sizing the government," Public Choice, Springer, vol. 145(1), pages 39-55, October.

Marica S. and Piras R. (2018), The relationship between government spending and growth: A survey, Rivista Internazionale di Scienze Sociali, 2, 123-151

Mauro L. and Pigliaru F. (2024), Italy's National Recovery and Resilience Plan: Will it Narrow the North–South Productivity Gap?, Italian Economic Journal, 10(3), 1281-1307

Mauro L. , Pigliaru F. and Carmeci, G. (2023). "Decentralization, social capital, and regional growth: The case of the Italian North-South divide," European Journal of Political Economy, Elsevier, vol. 78(C).

Nannestad P. (2008). What have we learned about generalised trust, if anything? Annual Review of Political Science, 11, 413-436.

Oto-Peralías D. and Romero-Ávila D. (2013), Tracing the Link between Government Size and Growth. Kyklos, 66: 229-255. https://doi.org/10.1111/kykl.12019

Persson, T., & Tabellini, G. (2000). *Political Economics: Explaining Economic Policy*. MIT Press.

Pressman J. and Wildavsky A. (1973) Implementation: How Great Expectations in Washington Are Dashed in Oakland; Or, Why It's Amazing That Federal Programs Work at All, This Being a Saga of the Economic Development Administration as Told by Two Sympathetic Observers Who Seek to Build Morals on a Foundation of Ruined Hopes, University of California Press.

Putnam R. D. (1993), Making Democracy Work. Civic traditions in modern Italy, Princeton-NJ: Princeton University Press.

Rahn R. and Fox H. (1996), What Is the Optimum Size of Government, Vernon K. Krieble Foundation.

Scully G.W. (1994), What Is the Optimal Size of Government in the United States?, National Centre for Policy Analysis - Policy Report, 188.

Scully G.W. (2003), Optimal taxation, economic growth and income inequality, Public Choice, 115, 299-312.

Svendsen G. L. H. and Svendsen G. (2016), How did trade norms evolve in Scandinavia? Long-distance trade and social trust in the Viking age, Economic Systems, 40, (2), 198-205

Tabellini G. (2010), Culture and institutions: economic development in the regions of Europe, Journal of the European Economic Association, 8, 677-716.

The Economist (2024), Governments are bigger than ever. They are also more useless, Section Finance & economics, issue September 28th 2024

Weber M. (1922), Economy and Society. University of California Press, Berkeley.

WVS (2009), World Value Survey 1981-2008 official aggregate v.20090902, 2009, World Values Survey Association, available at: http://www.worldvaluessurvey.org/.

Our Working Papers are available on the Internet at the following address:
https://www.feem.it/pubblicazioni/feem-working-papers/

"NOTE DI LAVORO" PUBLISHED IN 2025

1. M. A. Marini, S. Nocito, Climate Activism Favors Pro-environmental Consumption
2. J. A. Fuinhas, A. Javed, D. Sciulli, E. Valentini, Skill-Biased Employment and the Stringency of Environmental Regulations in European Countries
3. A. Stringhi, S. Gil-Gallen, A. Albertazzi, The Enemy of My Enemy
4. A. Bastianin, X. Li, L. Shamsudin, Forecasting the Volatility of Energy Transition Metals
5. A. Bruni, Green Investment in the EU and the US: Markup Insights
6. M. Castellini, C. D'Alpaos, F. Fontini, M. Moretto, Optimal investment in an energy storage system

Fondazione Eni Enrico Mattei
Corso Magenta 63, Milano – Italia

Tel. +39 02 403 36934

E-mail: letter@feem.it
www.feem.it

Fondazione Eni Enrico Mattei