ROMA TRE
UNIVERSITÀ DEGLI STUDI

**COLLANA DEL
DIPARTIMENTO DI ECONOMIA**

THE POLITICAL ECONOMY OF PUBLIC RESEARCH, OR WHY SOME GOVERNMENTS COMMIT TO RESEARCH MORE THAN OTHERS

Andrea Filippetti and Antonio Vezzani

The political economy of public research, or why some governments commit to research more than others

Andrea Filippetti and Antonio Vezzani

The political economy of public research, or why some governments commit to research more than others

Andrea Filippetti [a] and Antonio Vezzani [b,1]

[a] Italian National Research Council (CNR) and Birkbeck College, University of London
[b] University Roma Tre, Department of Economics

Abstract

Regardless a generalised consensus about the economic benefits of public research, it has been following different patterns across countries. Why do some governments invest in public research more than others? By relying on political economy literature, we frame investment in public research as a choice shaped by the political institutions of countries. We find robust relationships between public-funded research and political institutions. Countries with parliamentary forms of government, proportional electoral rules and bicameralism legislatures spend more in research; the presence of encompassing civic society organizations also encourages public research. Majoritarian-like reforms which reduce representation might discourage forward government commitment harming the long-term economic growth.

---

1. Introduction

The former President of the European Commission Jean Claude Juncker once quipped that policy makers know precisely what the right things to do are, but they do not know how to get re-elected once they have done it. This statement suggests the presence of some trade-off between the pursuing of the general public good, which in principle constitutes the overarching purpose of governments, and the reality of everyday politics. The balancing of this trade-off has significant implications for long-term economic growth because it affects the quality of public spending.

While the debate on big spending versus little spending has attracted most of the attention, we believe more emphasis should be put on the composition of public spending, and particularly to the trade-off between short-term redistributive spending vis-à-vis long-term investment spending. In fact, the prosperity of countries might depend on the balance between these two sets of policies. In particular, too much focus on short-term public interventions might undermine long-term prosperity.

We focus on a particular category of public spending, that of public research. We frame public investment in research[2] within a political economy perspective to explain why some governments fund public research more than others.

Let us start with the 'theory'. This says, in a nutshell, that investment in public R&D is good for the economy and for the society at large. As the National Science Foundation (NSF) put it, investment in public (basic) research is based on the belief that "*solutions to many of the challenges facing society have their roots in our scientific understanding, where technology increasingly drives the global economic engine."* (NSF, 2007).

Both economists and policy makers have reached unanimous consensus about the benefits that investments in public research exert on societies at large. Public research investments benefit the society by solving specific problems by means of breakthrough scientific discoveries such as vaccines and by opening up new technological trajectories (Dosi, 1982). Public research also benefits the private sector of the economy, where indirect effects have been much greater and far-reaching in industries such as the airplanes industry, energy, computer and telecommunication, automotive, pharmaceutical and bio-tech (Foray et al., 2012). In these industries, science and technology (S&T) knowledge spillovers from public research to business research have demonstrated to be significant (e.g. Bednyagin and Gnansounou, 2012; Kaiser, 2002). Further, public research also trains high-skilled labour force with advanced and close-to-the-frontier knowledge that eventually get hired in the private sector.

Let's now face the 'practice' of government-funded research by reporting a telling example (Freeman and van Reenen, 2009). In 2006, President Bush announced a programme whose centrepiece was to double the basic R&D spending over the next decade. The American Congress did not appropriate the funding due to a partisan disagreement and the greater importance of other *budgetary* and *political* considerations; "the results was a modest change in federal spending in R&D [...] and stagnant federal support to R&D overall that reduced spending in real terms" (p. 2).

---

[2] Throughout the paper we will use the terms research and research and development (R&D) interchangeably.

This example illuminates about the distance between the theory and the practice of government-funded R&D and introduces our main argument. Public R&D is a political choice of policy makers, and as such it is affected by the political environment in which it takes place, which in turn is affected by political institutions.

Anecdotal evidence suggests that increases in R&D spending have been often responding to political circumstances, especially since when basic science has become a key ingredient of technological change and innovation (Dosi, 1982; Nelson, 1959; Rosenberg, 1982). Ever since the military machines invented by Archimedes and Leonardo da Vinci, the Manhattan project funded by the U.S. during the second world war, the race to the moon during the cold war, until the recent introduction of mission-led innovation policy of the European Union, large surges in R&D spending have been often tied to specific policies and attached to major societal challenges (Foray et al., 2012).

Given the many benefits provided by investment in public research, claims for an increasing funding into public research are not surprising (Pisano and Shih, 2009). And yet, over the past decades we have observed a trend in the *reduction* of public research investment in terms of share of gross domestic product (GDP) and compared to private ones in most OECD countries: the average percentage of R&D financed by the public sector drop from 44.2% in 1981 to 28.3% in 2014 (Archibugi and Filippetti, 2018). In the U.S., over the period 1990-2006, the share of R&D funded by the federal government drop from 40.5% to 28.4%, corresponding to 0.11% and 0.07% of the GDP respectively (Freeman and Van Reenen, 2009).

The next chart (Figure 1) compares public-funded R&D, business-funded R&D, and overall public spending of government as shares of GDP. Two patterns emerge: (i) while both types of R&D expenditures show a clear trend, general government expenditure has a cyclical nature along the economic cycle; (ii) a generalised reduction of public R&D coupled with an increase of business R&D, with the gap among the two steadily increasing over the past four decades. Interestingly enough, in the age of liberalism we do not observe a trend toward a generalised reduction of the public budget. By contrast, we do observe a systematic reduction of public research which is more in line with a political emphasis towards a reallocation of resources from the public into the private sector or some kind of privatization of research (Archibugi and Filippetti, 2018). The ups and downs of public expenditure seem to be driven mostly by the role of public expenditure during recessions, also as a result of automatic stabilizers, as well as the reduction of the denominator (e.g. GDP).

The implications of these trends for long-term economic growth have been discussed from the perspective of the different nature of private R&D versus public R&D (Archibugi and Filippetti, 2018). Here we want to uncover some of the determinants of public research resorting on a political economy perspective. In fact, notwithstanding innovation scholars have reached a robust consensus about the benefits of public research, little attention has been devoted to investigating its political roots.[3] While a vast array of studies have for long investigated the political economy of several policies - e.g. redistributing policy, inflation targeting, fiscal policy, etc. - research addressing the political economy of public research is rather absent.

---

[3] Exceptions are the book The Politics of Innovation by Taylor (2016), the historical view by Mokyr (1998) about the obstacles towards innovations, and some recent work on public research in the health sector (Batinti and Congleton, 2018).

Fig 1: Public R&D, business R&D and general public expenditures as a share of GDP over time in 41 countries (1981-2017)
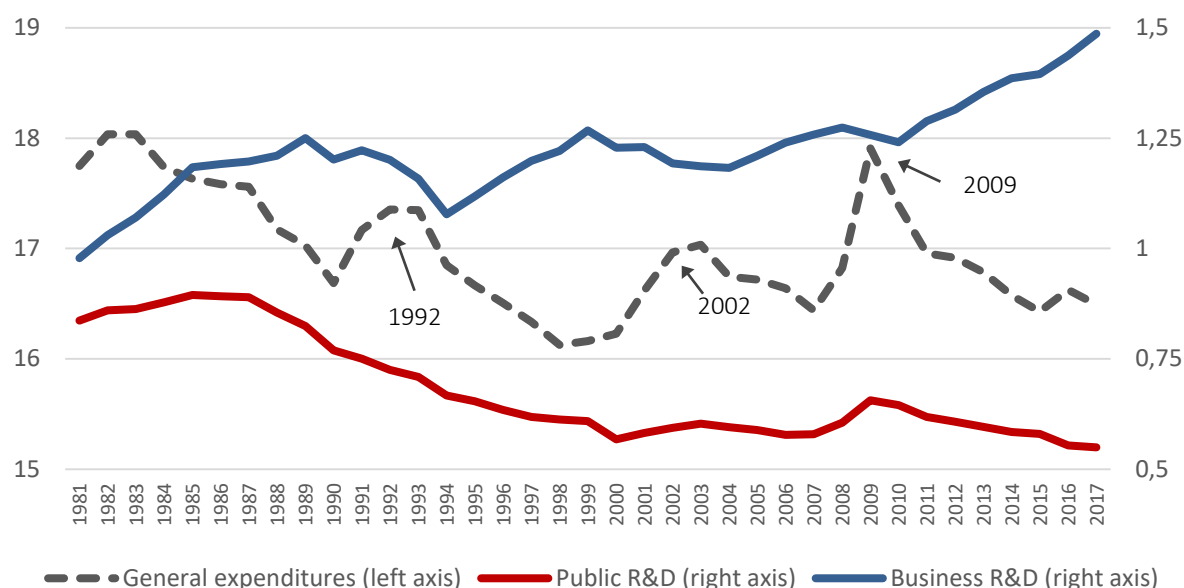
Note: Shares are weighted by a country GDP.

Hence our research question: *why do countries devote different amounts of public resources to research?* We conceive public R&D as a result of a *political process* that involves explicit choices over the whole public budget. Public R&D requires sizeable investment in human capital and physical infrastructures, whose benefits are *uncertain* and *future.* These financial resources are therefore allocated away from other activities such as welfare programmes, other social policies, infrastructures, tax cutting, and so on. As such, the decision to fund public research[4] is a *political decision* in that establishes priorities on such a programme over many desirable others.

One could argue that a drop in public-funded research is not bad news since it has been substituted by and large by business-funded research. However, one argument has been made about the different economic characteristics of public versus private research and about the possible negative consequences on long-term economic growth of such a perspective (Archibugi and Filippetti, 2018). Others have pointed out that the decline in basic research has dried up the common pool of knowledge with negative consequences on the rate of productivity growth (Archibugi et al., 2020; Dosi and Stiglitz, 2014; Pisano and Shih, 2009). Additionally, the major transition towards a more sustainable economy that both advanced and emerging economies are going to face in the next years is going to require a major boost in basic research. The current Covid-19 pandemic has also highlighted the need for a boost in public-funded research in the health sector.

Our approach aims at bridging innovation studies, namely studies on science and research public policies, with political economy research, namely constitutional political economy and particularly positive political constitutional economics. These two strands of studies have never crossed although they share the interest in how institutions affect economic outcomes. We assume the institutional setting to be given (or exogenous) and we investigate the impact on a specific type of public

---

[4] Note that we are dealing with public-funded research; most of this type of research is also carried out in the public sector, namely in universities and public research centres, while a fraction of it is also performed in the private sector, e.g. by contracting.

investment. Investigating the economic effect of given formal political institutions is the area of intersection between the positive strand of constitutional economics developed within the larger umbrella of public choice school and the strand of empirical studies that have followed on the political economy mainstream approach developed, among others, by Persson and Tabellini (Voight, 2011).

Studies on science and public research have taken different approaches to explain the patterns of investment in research and innovation across countries in which institutions play a great role, including long-term historical perspectives, as those illustrated by Joel Mokyr (1992). In the National Innovation System (NIS) approach the innovation performance of countries depends on the linkages among actors. Virtually all definitions of NIS involve the role of institutions and how they shape the network of innovation generation and diffusion (Freeman, 1995; Lundvall et al., 2002; Nelson, 1993). Another institutional-based theory of innovation is that developed by the Varieties of Capitalism research (Hall and Soskice, 2001); here different institutional settings – including the labour market, the financial sector etc. – are expected to encourage different ways of organizing innovative activities, ultimately leading to different innovation patterns (for empirical counter-evidence see Akkermans et al., 2009). These theories show how the domestic institutions, including the labour market, education and training, the research system or the financial sector, explain a significant fraction of innovation performance of countries (Ciriaci et al., 2019; Holm et al., 2010; Filippetti and Guy, 2020).

This literature has two main limitations. Firstly, quite little attention has been devoted to the decisional political process leading to the funding of public research. Secondly, it is mostly concerned with explaining the performances in terms of innovation, both at the micro and at the macro level. While studies on public research have focused on demonstrating its far-reaching benefits on the economy (Becker, 2015; David et al., 2000; Foray et al., 2012; Hall and Soskice, 2001), we lack research aiming at explaining public-funded research *per se*. In other words, these studies treat public research as exogenous, while we treat it as an endogenous outcome determined by the policy decision making process.

The positive branch of constitutional political economy has been concerned with explaining the economic effects of alternative constitutional rules (Voight, 2011), and in particular the effects of the constitutional rules on political decisions and economic policy outcomes (Mueller, 2003; Persson and Tabellini, 2002). This strand of research explores how alternative rules of the game set by constitutional rules shape the behaviour of policy makers and, ultimately, their economic policy agenda. We are interested in those studies analysing how the institutional settings encourage investment in general public goods in opposition to narrow-targeted public investments (Lizzeri and Persico, 2001). We focus on two types of political institutions that have been demonstrated to affect the political process and the policy agenda. The first type derives from the constitutional rules, i.e. the form of government (presidential versus parliamentary), the electoral rule (majoritarian versus proportional), and the unicameral versus bicameral structure of the government.[5] The second are the civil society organizations, or groups of interest, i.e. organizational layers of the polity that lie between

---

[5] The effects of the constitutional rules on political outcomes (e.g. from the form of government to the number of parties or the duration of governments) has been the realm of classical comparative political theory (Lijphart, 2012). The public choice approach has focussed on 'constitutional democracy' by proposing several normative theories about the economic consequences of constitutional design (Buchanan and Tullock, 1962; Mueller, 2003); recent contributions on political economy have also questioned the constitutional effects on economic policy and economic performance (Persson and Tabellini, 2002). For a review (Voigt, 2011) and an enjoyable *querelle* on the latter two approaches (Blankart and Koester, 2006).

the state and private citizens which have come to play a stable role in shaping policy making and the agenda of government.[6]

We employ a sample of 41 countries from the Main Science and Technology Indicators (MSTI) of the OECD and run different two-way panel fixed effect estimations, trying different specifications, to test our research hypotheses. Our evidence points to a robust relationship between public-funded investment in research and the institutional structure of countries. Parliamentary forms of government, proportional electoral rules and bicameralism legislature are conducive to public research. We also find a strong positive correlation between the presence of encompassing civic society organizations and public research.

2. The political economy of public research

In this section we will first frame public investment in research as a political choice. We then rely on research on the economics of constitution and political economy to derive three hypotheses about the relationship between political institutions and public research expenditure.

2.1 Public investment in research as a long-term political commitment

The rationale for public intervention in sustaining R&D activities is rooted in some fundamental contributions that have highlighted the public (in fact quasi-public) nature of research (Arrow, 1962; Dosi and Stiglitz, 2014; Nelson, 1959). Hence, the funding of public research by governments can be though as a problem of producing a general public good (Archibugi and Filippetti, 2015).

We conceptualize public-funded research as a political choice whose level of funding goes through a political process, which in turn depends on some formal institutions. In order to establish a link between political institutions and public research, we rely on the fact that "*constitutions are concerned with mechanisms for the production of public goods*" (Voigt, 2011, p. 146). As Voigt (2011) continues "*societies do not decide in any meaningful detail what sort of public good they want to provide themselves with; rather the constitutions contain the provisions that are intended to be used in making those decisions. They therefore constrain the representatives of society in the ways they choose what public goods should be produced*".

In order to conceptualize public research as a political choice we introduce a categorization of public expenditures along two dyadic categories: short-term vs long-term results and targeted vs. general benefits. Short-term policies include policies like monetary transfer to people, as in the case of social insurance policies, or tax incentives to companies; long-term policies include policies such as education, research, broad infrastructures. Public expenditure can be targeted or general, depending whether the benefits accrue to a specific portion of the population (targeted) or to a large fraction of the population (general) (see Figure 2).

In terms of the first trade-off – short-term versus long-term returns – political systems tend to suffer from *short-termism*, for several reasons. Individuals prefer short-term results to long-term since the

---

[6] Compared to the research on institutions, our set of political institutions can be thought as a sub-sample of *formal* institutions.

latter are less easy to calculate and more uncertain, hence citizens (read voters) themselves prefer short-term policies. Politicians tend to have a preference towards projects that make them accountable to the voters and might improve their political consensus (Garrì, 2010). Hence, projects with near costs and future benefits are relatively less appealing that short-term projects which have noticeable benefits within the next elections. Importantly, a third source of short-termism is related to special interest groups which, as discussed later-on, use their political influence to shape the political agenda. To the extent that they have short-term interests they can increase the degree of short-termism of governments' policies. As such, there are several sources that will tend to push the temporal frame pendulum of policies towards the short-term end (González-Ricoy and Gosseries, 2016).
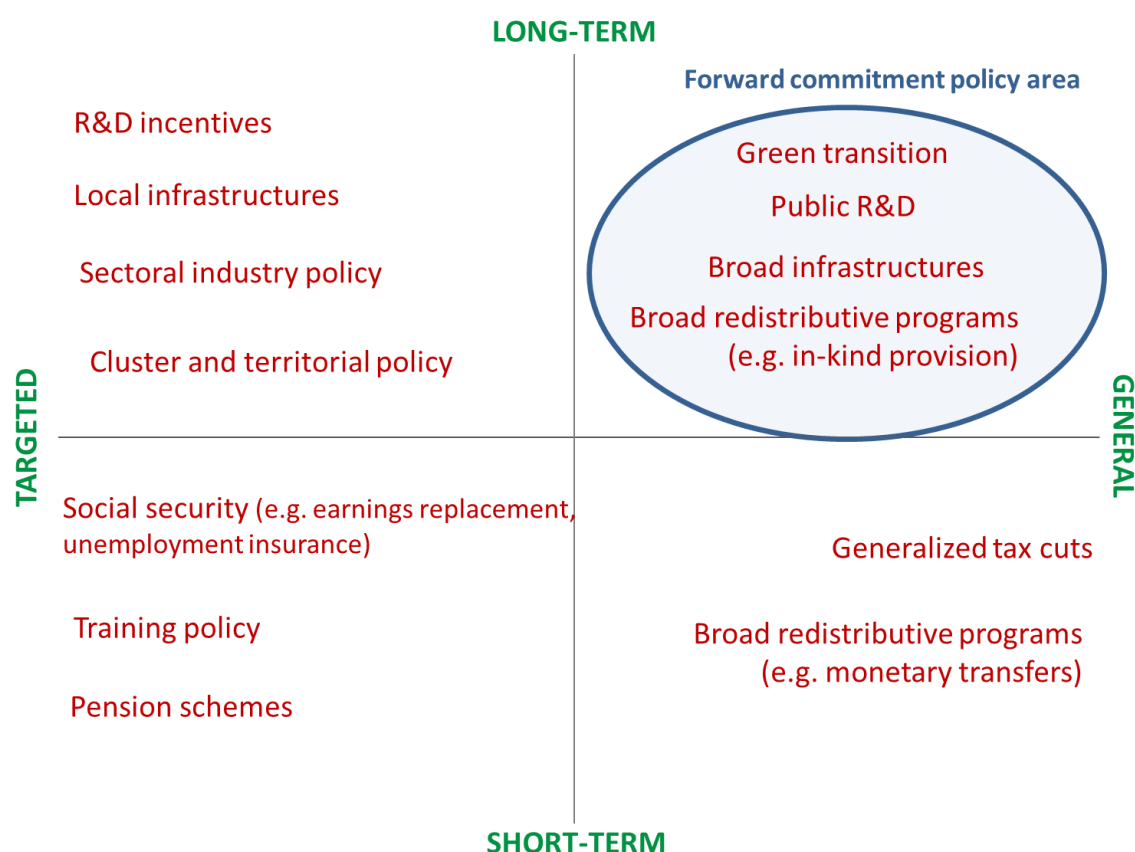
The distinction between targeted towards un-targeted (general) is of great importance for our argument. The political economy has been deeply concerned with studying the political conflict between public programs that benefit a large fraction of the society versus programs whose benefits are targeted to a specific group of population. The former are general public goods and broad redistributive programs, while the latter are local public goods (like regional infrastructures) and specific (re)distributive programs.

Policy makers would choose projects for which they can claim credit with the electorate. For this reason *"public goods are bad because voters do not know whether the candidate was really instrumental in securing the provision of the public good, whereas it is easy for candidates to claim credit for a local pork-barrel project"* (Lizzeri and Persico, 2001, p. 227). An interstate motorway or a high-speed railway will be categorised as a *general* policy; by contrast, a local motorway will be a *targeted* type of policy. There are theoretical arguments suggesting that different constitutional rules and political institutions can affect policies, particularly the political choice between broad government programs versus narrow and targeted programmes (Huber et al., 1993). Hence, in addition to short-termism, governments can also suffer from a narrowness of policy that will crowd out the production of general public goods.

We can now discuss the nature of public research within the policy space depicted above. We are particularly interested in the upper-right quadrant of the chart that we label ***forward commitment policy area***. Political economy would regard both broad redistributive programs and public research as fitting the category of broad public programs. Here we are adding the long-term dimension as an additional necessary feature to identify the forward commitment policy area. This area includes public programs such as general infrastructures (e.g. national digital infrastructures), investments in sustainable transition of the economy and funding in public research.[7]

Figure 2: The space of public policy along two dimensions: short-term vs. long-term and targeted vs. general

---

[7] True, an increase in funding in bio-tech research versus an increase in the defence industry has direct benefits on a different set of researchers and indirect effects on related industries. In fact, researchers do lobby for public funding (Congleton et al., 2017). However, the benefits will accrue to the whole society ultimately depending on the public-good nature of the knowledge generated and the subsequent spillovers.

LONG-TERM

Forward commitment policy area

R&D incentives

Local infrastructures

Sectoral industry policy

Cluster and territorial policy

Green transition

Public R&D

Broad infrastructures

Broad redistributive programs
(e.g. in-kind provision)

TARGETED

GENERAL

Social security (e.g. earnings replacement, unemployment insurance)

Generalized tax cuts

Training policy

Broad redistributive programs
(e.g. monetary transfers)

Pension schemes

SHORT-TERM

Summing up, we have framed public-funded R&D within a political economy logic. Public research is conceptualized within the notion of long-term commitment policy area, characterized by long-term results and general programs. This type of policy is particularly relevant in that it entails those types of investment that bring about long-term economic growth. At the same time, policy can have a bias towards short-term and narrow programs. This is essentially the Junker trade-off we mentioned at the outset. Thus, it becomes crucial to identify if and what are those institutional settings that encourage long-term commitment policy, and particularly public research.

2.2 Political institutions and public investment in research: three research hypotheses

Research on constitutional economics has put forward a number of positive theoretical arguments about the economic implications of constitutional arrangements and the related functioning of various political institutions (Buchanan and Tullock, 1962; Mueller, 2003). This has spurred a lot of empirical research showing how formal institutions shape public economic policies, and affect several economic and financial aggregates, such as the rate of economic growth, the size of the budget, public debt, etc. (Persson and Tabellini, 2002; Voigt, 2011).

We derive three research hypotheses by relying on this literature about three sets of political institutions: 1) form of government and electoral rules; 2) unicameral versus bicameral legislature; 3) the presence of civil society organizations. What these three sets of institutions have in common is that they constitute the foundation of the political decision process. The first two are the most fundamental constitutional rules in modern democracies, while the third has become a structural characteristic of the political process.

We are not considering a number of other factors, such as the number of parties, the stability of governments, coalition governments etc., for two reasons. Firstly, they are usually defined as political outcomes, as such deriving from our first set of political institutions, and this has been explored in comparative politics. Second, they tend to change often, while here we are interested in the structural institutions. Hence, we are not going to focus on the presence of intermediate effects between the constitutional rules, e.g. electoral rules, and the political outcomes, e.g. the number of parties or coalition governments. We are also assuming that our political constitutions are exogenous in that they do not depend on the long-term countries' performances, which is a plausible hypothesis especially considering the sample of countries used in the analysis.

Form of government and electoral rules

The two most relevant constitutional-derived political institutions that have been considered in political economy are the form of government, i.e. parliamentary versus presidential, and the electoral rules, i.e. proportional versus majoritarian (Blume et al., 2009; Persson and Tabellini, 2004). The latter determines the aggregation of voters' preferences and how the power to make political decisions is distributed over different representatives. The former determines how these powers are exercised in office. Arend Lijphar (1999) proposes a distinction between two ideal types of democracy, namely *consensual* and *majoritarian* democracies. The former is characterized by having institutions that maximise the sharing of power; by contrast, in the latter power tends to be concentrated in the hand of the majority. Consensual democracies are characterized by a parliamentary form of government which legitimises the executive power, and a proportional electoral rule that maximises the representatives of minorities in the parliament. By contrast, majoritarian democracies are the result of a presidential regime (with a strong separation between the executive and the legislative functions) and a majoritarian electoral rule which aims at identifying a clear-cut majority.

Lizzeri and Persico (2001) show theoretically that general public goods are better funded in proportional regimes. In majoritarian systems marginal groups of voters are more relevant for re-election; as a result, one will observe narrow programs towards these groups of citizens. Hence, in majoritarian systems "politicians have an incentive to cater to those which help them obtain a plurality of the votes and they will do so by promising pork-barrel, i.e. narrow-interest projects. By contrast, in proportional systems narrow targeting makes less sense because every vote counts, *leading politicians to provide more general public goods*" (Voigt, 2011, p. 217). From this perspective, the Unites States is the typical example of a constitutional design that encourages logrolling and pork-barrel activities hence discouraging the funding of general public goods (Tullock and Palda, 1994).

Summing up, presidentialism and majoritarian electoral systems tend to produce much dispersed political power with multiple points on influence on policy that will result in less incentives to produce broad government programs versus targeted programs (Huber et al., 1993; Lijphart, 2012; Persson and Tabellini, 2002).

Another issue about the majoritarian-presidential dyad is the importance of policy reversal, which tend to decrease when a large number of political actors is involved in a policy and vice versa (Voigt, 2011). The threat of policy reversal generates stronger incentives towards short-term policies.

Taking stock of the foregoing discussion we posit:

Bicameral versus unicameral legislature

Another institutional dimension deriving from the constitutional rules is unicameral versus bicameral legislature. The roots of the two chambers system go back to centuries when specific groups wanted to have a say in national parliaments by having their own chamber, as it is the case of the House of Lords in the British Parliament. Another historical reason is related to federal countries in which it is customary to have a second chamber, in addition to the lower one, where nations or regions are represented.

In a theoretical study, Congleton (2003) finds that bicameralism improves public policy by making it more predictable and consensual; further, and crucially for our purpose, he finds that *bicameral legislatures* adopt policies that are more adherent to the *long-term interests* of the median voter than those adopted by the unicameral legislatures. To the extent that the median voter is more interested to general public good (i.e. un-targeted policy) than targeted policies, bicameralism can support investment in public research.

Bradbury and Crain (2002) propose that bicameralism should make public spending more efficient not only by limiting spending, but by "limiting agreement to the set of policies agreed upon the median constituents of both chambers" (p. 655). They find that bicameralism limits funding to redistribution policies while improves funding to general public goods; in particular, they find that bicameralism predicts expenditures in long-term programmes such as education and highways. A more indirect argument is that by improving stability of governments, bicameralism makes long-term policies more likely to be funded (Voigt, 2011).

Summing up, even though there are few studies that have looked to bicameralism from the perspective of political economy, these studies suggest a positive relationship between bicameralism and the funding of long-term policies towards the production of general public goods; hence it follows that:

Hypothesis #2: bicameral (versus unicameral) legislature is more conducive to public-funded research

Group pressures and civil society

Our last hypothesis concerns the role that civil society organizations (CSO) or groups of interest play in shaping policy making. CSO are organizational layers of the polity that lie between the state and private life. The rationale for including them stems from the fact that they play a key role in shaping policy making and the agenda of government. Political theory considers CSO as a necessary actor when analysing the distribution of power within contemporary societies; in fact, they represent a constitutive part of the political institutions. By limiting research to the formal political institutions –

i.e. the government and the parliament - one does not capture the whole range of forces that affect policy making within a society.[8]

CSO are institutions in which "individuals act collectively, rather than individually or privately" (Buchanan and Tullock, 1962, p. 292). They have become integral part of the political process to the extent that: *(i)* the public budget has grown over the year and therefore the 'cake' has got larger, and so the expected returns from CSO activities; *(ii)* while in principle policy should pursue the 'public interest', there is hardly any political choice that has the same benefits and costs on the entire population; *(iii)* conflicts among pressure groups have become an essential part of the democratic process (Buchanan and Tullock, 1962).

It remains to be determined what the theory tells us about the relationship between CSO and long-term policies oriented towards general public goods.

Long ago Adam Smith in his *Wealth of Nations* already raised sceptical arguments about the possibility that collective action of interest groups would be detrimental to public wealth, i.e. "a conspiracy against the public". These concepts – collective action in organizations, the interests of the groups, and public costs – have been further developed theoretically by Mancur Olson in his *The logic of Collective Actions* (1965). However, the key predictions about the impact of interest groups on policy and economic growth has been put forward in *The Rise and the Decline of Nations* (Olson, 1982) where he argues that this type of associations is detrimental to aggregate efficiency and economic growth. The harmful impact on economic growth is mediated by the composition of public policy: associations – named *distributive coalitions or special interest-groups* – will push for redistribution policies in favour of the common interests of their members, at the expenses of the whole society. Crucially, this will be done by diverting resources from growth-enhancing programs such as investments and innovation. By contrast, *encompassing associations* are not expected to lobby for special interests, but rather for more general public goods. This occurs because encompassing organizations have come to represent a substantial portion of the society; in these cases, favouring growth-enhancing policies is more effective for the members themselves of the organization, rather than acting on (possibly) growth-harming redistribution policies.

Even the same associations, such as trade unions, can have opposite effects on public policies. While they are usually treated as an example of redistributive actors, aiming to get a larger fraction of income for their workers, there have been cases in which trade unions have acted in favour of productivity-enhancing policies, even renouncing to increases of wages. A case in point is represented by the evolution of the unions in Italy over the 1950s where the emphasis on *income distribution* has been progressively substituted by that on *income and productivity growth.* Since then, the role of the union has been increasingly that of expanding national wealth by taking care of dynamic efficiency. This has culminated in the agreement of 1993 between the Italian government, the industry associations and the trade unions, when the latter agreed to curb real wages to keep inflation low in order to increase overall economic efficiency, competitiveness and economic growth. Thus, large encompassing

---

[8] This approach owns a lot to the Italian school of public finance that has been active from the late XIX century to the 1940s. This school paved the ground for the subsequent elaboration of the role of the elites in public policy, as recognized for instance by Schumpeter in his theory of democracy. The school has also played a fundamental role for the elaboration of normative rules of constitutional economics in the realm of public choices, as recognized by both Buchanan and Tullock.

organizations agreed to put aside their special interests in exchange of benefits for the society as a whole.

A more general case of a positive relationship between associations and economic performance has been put forward by research on social capital. To cut a long story short, social capital improves institutional performance and ultimately economic growth by favouring civic networks and interpersonal trust.[9] The presence of social capital enhancing CSO will therefore favor long-term investment policy. Communities rich with social capital prefer long to short-run political-economic strategies (Andriani and Sabatini, 2015). Social capital is associated with public investment for the implementation of socio-economic and sustainable forward-looking public policies in favor of public safety, public health, public education, and environmental protection (Pierce et al., 2016; Schneider, 1987). Social capital also helps explain individuals' attitudes towards planning capacity and forward-looking decision making. Individuals holding social capital tend to prefer decisions forward-looking oriented (Anand and Poggi, 2018). When this turns into political pressure it encourages forward-looking policy, favoring long-term public investments (Batinti et al., 2019).

In light of the discussion above, we would posit that:

Hypothesis #3: the presence of encompassing CSO is more conducive to public-funded research

3. Data and variables

To test our hypotheses on the relationship between political institutions and public research expenditure we build a longitudinal dataset with country level observations combining information from different sources. In table 1 we report a detailed description of the variables presented hereafter.

We use two measures to capture the public effort in R&D and the overall public spending of governments. From the Main Science and Technology Indicators (MSTI) of the OECD we retrieve our main dependent variable, the government-financed gross domestic expenditure on R&D (GERD) as a percentage of GDP. This variable captures the amount of overall income that countries devote to public research and is measured as the total intramural expenditure on R&D performed in a national territory during a specific reference period financed by the government, and performed mostly in the public sector but also in the private sector through contracting; we will refer to this variable as *Public R&D*.[10] From the World Bank Development Indicators (WDI) we retrieve the General government final consumption expenditure as a share of GDP (*General public expenditures*). The variable is used both to compare public R&D to general expenditures and to compute public R&D as a share of general expenditures. The latter is meant to capture the allocation of government-funded R&D relative to other types of expenditures.

---

[9] See Andriani and Christoforou, 2016; Putnam, 1993; for empirical evidence see among others (Akçomak and ter Weel, 2009; Crescenzi et al., 2013; Knack and Keefer, 1997; Zak and Knack, 2001).

[10] The MSTI collect information for the OECD member countries and other 7 economies from 1981 to 2017. The list of 41 countries included in the analysis and the first year for which Public R&D is available can be found in table A.1 of the appendix. The original variable contains some missing values, we fill these values through a linear interpolation. In the robustness checks (table 4) we report the results using the original variable to show that the interpolation procedure does not significantly affect our main results.

From the WDI we also retrieve two variables meant to control for possible socio-economic factors that might act as confounders for the relationships at stake and that we should take into account to identify the parameters of interest. We consider the per capita GDP in purchasing power parity (*Per capita income*) and the share of total population aged 65 years or more (*Older population*). The former aims at capturing the possibly different role of the state (and its institutional setting) along a country development (e.g. Reinert, 1999), while the latter may impose a conundrum for governments in balancing between long-term productivity enhancing policies and social and pension policies. The descriptive statistics and the correlation table reported in the appendix (table A.2 and A.3, respectively) show that the variability of these two socio-economic controls and their correlation with our variables of interest are not negligible, suggesting that their inclusion may provide more reliable estimates for our parameters of interest.

We retrieve our set of institutional variables from the 2019 edition of the Varieties of Democracy (V-Dem) Project, which proposes a new approach to conceptualize and measure democracy (Coppedge et al., 2019). The coefficients attached to the variables derived from this dataset will allow us to confirm or confute our research hypotheses. In particular, we use the variables *Presidential* and *Proportional* to characterize the form of government and the electoral regime (HP. 1); *Bicameralism* to test the role of the two chamber system in determining the long-term commitment of a country political system (HP. 2), and; *Encompassing CSO* to test whether systems were the government grants a special role to large and encompassing CSO are more conducive to *Public R&D* compared to systems were the voice of civil society is fragmented and contingent on specific circumstances (HP. 3).

We also include the variable *Check and balances* to consider the possible role of different institutions monitoring and controlling the actions of the executive power. We do not have a clear a priori of this control in determining the long-term commitment of governments; however, we include this variable because has been proven to limit possible inefficiency in the political process and, ceteris paribus, to reduce general government expenditures (Henisz, 2000). Finally, we include a variable to control for the presence of constraints in public expenditure (Budina et al., 2012). The variable – *expenditure rule* – is a binary variable signaling the introduction of provisions to limit public spending. This variable can take various forms: some countries establish a maximum rate of public spending over GDP (e.g. ceiling on the expenditure-to-GDP ratio of 40 percent), others limit the increase in spending (e.g. 1 per cent in real terms). We prefer this variable to those related to debt sustainability because it does not involve the revenue side. We expect this variable to be negatively correlated with public spending.

Table 1: Variables used in the empirical analysis

Variable name	Dataset	Item in the dataset	Description
Public R&D	MSTI (OECD)	G_FGXGDP	Government-financed gross domestic expenditure on R&D (GERD) as a percentage of GDP. GERD is the total intramural expenditure on R&D performed in the national territory during a specific reference period.
Per capita income	WDI (World Bank)	NY.GDP.PCAP.PP.CD	This indicator provides per capita values for gross domestic product (GDP) expressed in thousands of international dollars, converted by the purchasing power parity (PPP) conversion factor.
Older population	WDI (World Bank)	SP.POP.65UP.TO.ZS	Population aged 65 and above as a percentage of the total population. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship.
General public expenditures	WDI (World Bank)	NE.CON.GOVT.ZS	General government final consumption expenditure as share of GDP (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defense and security but excludes government military expenditures that are part of government capital formation.
Proportional	V-DEM	v2elparlel	What was the electoral system used in this election for the lower or unicameral chamber of the legislature?
			Proportional = 1 if proportional; 0 if majoritarian or mixed.
Presidential	V-DEM	v2ex_elechos	Is the head of state HOS directly elected?
			Presidential = 1 if yes; 0 if not.
Bicameral	V-DEM	v2lgbicam	How many chambers does the legislature contain?
			Bicameral = 1 if 2 chambers; 0 otherwise.
Encompassing CSO	V-DEM	v2csstruc	Civil societies inevitably involve a mix of larger and smaller organizations, it characterizes the relative influence of large mass constituency CSOs versus smaller, local, or narrowly construed CSOs.
			CSO large = 1 if more than 50% of experts state that large encompassing organizations dominate; 0 otherwise.
Check and balances	V-DEM	v2xlg_legcon	To what extent are the legislature and government agencies e.g., comptroller general, general prosecutor, or ombudsman capable of questioning, investigating, and exercising oversight over the executive?
			It is a numeric variable with range (0,1). It is formed in V-DEM by taking the point estimates from a Bayesian factor analysis model of a series of indicators.
Expenditure rule	FAD (IMF)	ER: Expenditure rule	It is a binary variable taking value 1 for the years in which an expenditure rule is in place; 0 otherwise.

4. Empirical analysis

In this section we present our empirical investigation. First, we present some patterns regarding our institutional variables and comment on the different tendencies of *Public R&D* across the countries of our sample. Second, we introduce and comment two-way panel estimations where we assess the validity of our research hypotheses. Third, we compare *Public R&D* with *General government expenditures*. Fourth, we explore the temporal relevance of our institutional variable. Finally, we perform some robustness checks.

4.1 Some descriptive statistics on the institutional variables

In figure 3 we report the share of countries in the sample having a specific institutional setting (left axis) and the number of countries with available information in V-DEM (right axis). As expected, political institutions depending on the constitutional rules change quite slowly. The share of countries with a presidential form of government increases over time, as well as that with a proportional electoral rule; bicameralism remains quite stable over time. By contrast, the decrease of relevance of encompassing CSO is much stronger, a tendency that has been halted following on the 2009 crisis.

In the appendix we report public R&D by country in figure A.1. Mixed patterns arise reflecting different choices made by the governments about investment in public research. In some cases, namely in the USA and in United Kingdom, the retreat of government from public R&D has been remarkable. On the contrary, countries such as Austria, Denmark and South Korea, have opted for a much stronger involvement of government in public R&D. Finally, in some countries the pattern has been rather flat.

Figure 3: Number of countries and their share with a given institutional characteristic
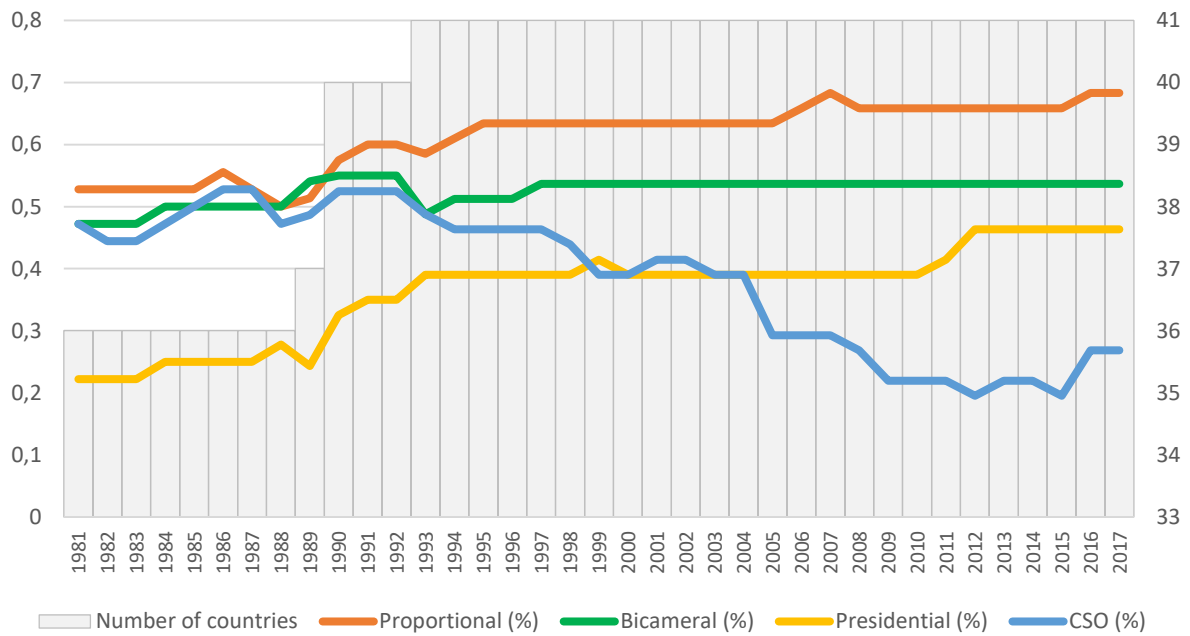
Note: Our elaboration on V-DEM data. Estonia, Lithuania, Latvia, Slovakia, and Slovenia acquire independency during the period analyzed.

4.2 Do institutional settings influence the level of government R&D expenditures?

This section illustrates the results of a series of two-way fixed effect regressions aiming at testing our three hypotheses. We analyse the relationship between institutional setting and government R&D expenditures by estimating variants of the following equation:

$$Public\ R\&D_{it} = \theta_1(socio\_economic)_{it} + \theta_2 X_{it} + \theta_3(oth\_insitution)_{it} + c_i + d_t + u_{it} \quad (1)$$

where i and t are country and time indicators, $socio\_economic$ stands for the two socio-economic controls presented above, X_{it} is the set of institutional measures we are interested in, $oth\_insitution$ stands for *check and balances* and *expenditure rule*, c_i and d_t represent country and time fixed effects, and e_{it} the error term.

The two-way fixed effect approach allows us to control both for country specific time-invariant determinants of *Public R&D*, and for unobserved determinants that vary commonly across countries during the period of observation, as well as for the shocks that have hit the economies during the period of analysis (e.g. the 2009 crisis).

When estimating equation (1) we gradually include the institutional variables relative to our research hypotheses. In this way, we introduce sequentially the tests of our hypotheses and provide a first insight of the stability of the estimated coefficients. The regression results are reported in table 2.

The first result in column 1 shows a positive correlation between income per capita and older population, and *Public R&D*. These results are consistent with the idea of public research as a superior good and the idea that with less active population countries need to invest more in innovation and technology to keep their productivity improving. Government commitment in public research may be also functional to sustain (or maintain) the welfare state against the growth of the inactive population.

Table 2: Drivers of public R&D expenditures, two-way fixed effects regressions

	(1)	(2)	(3)	(4)	(5)
Per capita income	0.003***	0.003***	0.003***	0.002**	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Older population	0.016***	0.018***	0.018***	0.016***	0.015***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Proportional		0.068***	0.069***	0.056***	0.043**
		(0.016)	(0.016)	(0.017)	(0.017)
Presidential		-0.031	-0.037*	-0.037*	-0.035*
		(0.021)	(0.021)	(0.021)	(0.020)
Bicameral			0.231***	0.216***	0.215***
			(0.023)	(0.022)	(0.023)
Encompassing CSOs				0.070***	0.061***
				(0.013)	(0.013)
Check and balances					-0.052
					(0.052)
Expenditure rule					-0.058***
					(0.013)
Constant	0.056	-0.002	0.019	-0.045	-0.279
	(0.239)	(0.242)	(0.243)	(0.246)	(0.248)
Observations	1,229	1,229	1,229	1,229	1,229
R-squared	0.794	0.797	0.799	0.805	0.810
RMSE	0.110	0.109	0.109	0.107	0.106

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All regressions include country and time fixed effects.

The results in column 2 confirm our first hypothesis: proportional electoral rule and parliament forms of government predict higher investment in public research. Results in column 3 confirm our second hypothesis about the positive effect of bicameralism on public research. Results in column 4 also confirm our hypothesis about the positive role expected from the presence of encompassing CSO. Finally, the full model reported in column 5 does not show significant changes in the estimated coefficients; as expected the presence of a fiscal rule on public spending is negatively correlated with our dependent variable.

4.3 The allocation of Public R&D within general public expenditures

A doubtful reader could comment that *Public R&D* is part of the *General public expenditures* and therefore our estimations are possibly replicating more general relationships between institutional settings and public expenditure. To dispel this kind of doubts we present in this section the results of a seemingly unrelated regression where *Public R&D* and *General public expenditures* are the dependent variables in a model with the full specification reported in table 2 (col. 5).[11]

Results are presented in table 3. The coefficients for the two equations are statistically different. When looking at *general public expenditures*, the signs of the two political institutions variables – form of government and electoral rule – are the same as in our main regressions and in line with much of the literature finding that consensual democracies have a larger budget; by contrast, the coefficient of bicameralism is not statistically significant. Interestingly enough, also the coefficient attached to encompassing CSO in not different from zero when looking at general public expenditure. This reinforces the idea that they might not be pursuing for a larger public budget aiming at redistributive policies. It seems to be rather the case that encompassing organizations are advocating for selecting forward commitment policies, as discussed above for the case of the Italian unions.

In the last column of table 3 we report the results of a regression where *public R&D* is defined as a share of general public expenditures. This provides a measure of the share of general expenditures that governments allocate to *Public R&D*, thus capturing the role of our political institutions in determining the allocation of public expenditures to forward commitment policies (R&D in particular). The results confirm that countries with proportional electoral rule, bicameralism and encompassing CSO allocate a larger fraction of their budget to public engagement in research with respect to alternative spending.

---

[11] We use a SUR approach because it allows a straightforward setting to test the equality of coefficients in the two equations and to inspect the correlation of the error terms.

Tab 3: Comparing public R&D with general public expenditures

	Public R&D	General public expenditures	Testing equality of coefficients	Public R&D as share of General expenditures
Per capita income	0.002*	-0.046***	0.000***	0.0002***
	(0.001)	(0.011)		(0.001)
Older population	0.015***	0.317***	0.000***	0.0003*
	(0.003)	(0.039)		(0.000)
Proportional	0.043***	0.543**	0.018**	0.002**
	(0.017)	(0.217)		(0.001)
Presidential	-0.035	-1.583***		-0.000
	(0.024)	(0.307)		(0.001)
Bicameral	0.215***	0.032		0.011***
	(0.077)	(0.998)		(0.001)
Encompassing CSOs	0.061***	-0.097		0.003***
	(0.011)	(0.147)		(0.001)
Check and balances	-0.052	-0.463		-0.002
	(0.058)	(0.749)		(0.003)
Expenditure rule	-0.058***	-0.926***	0.000***	-0.002***
	(0.010)	(0.136)		(0.001)
Observations	1,228	1,228	Rho: 0.398	1,228
R-squared	0.81	0.891		0.863

Note: Standard errors in parentheses (robust standard errors in the last column). *** p<0.01, ** p<0.05, * p<0.1. The regressions include country and time fixed effects. The Breusch-Pagan test suggests that the hypothesis of no correlation of the error terms of the two equations can be safely rejected. The Wald test for the equality of the coefficients across the two equations suggests that also this hypothesis can be safely rejected. Rho is the correlation of the error terms of the two equations.

4.4 Regressions with year interacted

In this section we explore whether the common decreasing trend in public research discussed before is moderated by the institutional settings of a country. In so doing, we are not testing our hypotheses with a different approach, but rather trying to establish some stylized facts on the relationships at stake that may be useful to further thinking about the political economy of public research. In other words, we try to answer to the following question: beside the general decreasing tendency in *Public R&D*, what institutional variables can have contributed to determining the different patterns observable across countries (figure A.1)?

To answer to this question, we estimate four equations of the type:

$$ Public\ R\&D_{it} = \theta_1(socio\_economic)_{it} + \theta_2 X_{-xit} + +\theta_2(oth\_institution)_{it} + d_t(1 + \gamma x_{it}) + c_i + u_{it}\ (2) $$

The specification is similar to (1), but now the term $d_t(1 + \gamma x_{it})$ indicates that in addition to the time fixed effects we also interact them with our institutional variables. In particular, in each regression we interact one institutional variable with the time dummies (this is the x in small caps) holding constant the effect of the other institutional variables (X_{-x}). A similar approach has been first used by Blanchard and Wolfers (2000) to study the interaction of shocks and labor-market institutions in determining some stylized facts of European unemployment, and Persson and Tabellini (2002) in their analysis of the effect of constitutions on fiscal policies.

In the following, we do not report the regression results - which for the non-interacted variables are similar to those presented in table 2 - but focus on the marginal effects of each institutional variable across time. To do so we report the estimates of γs and their 95% confidence interval in figure 4.

Fig 4: Marginal effects of the institutional variables over time

95% confidence interval reported in dotted lines
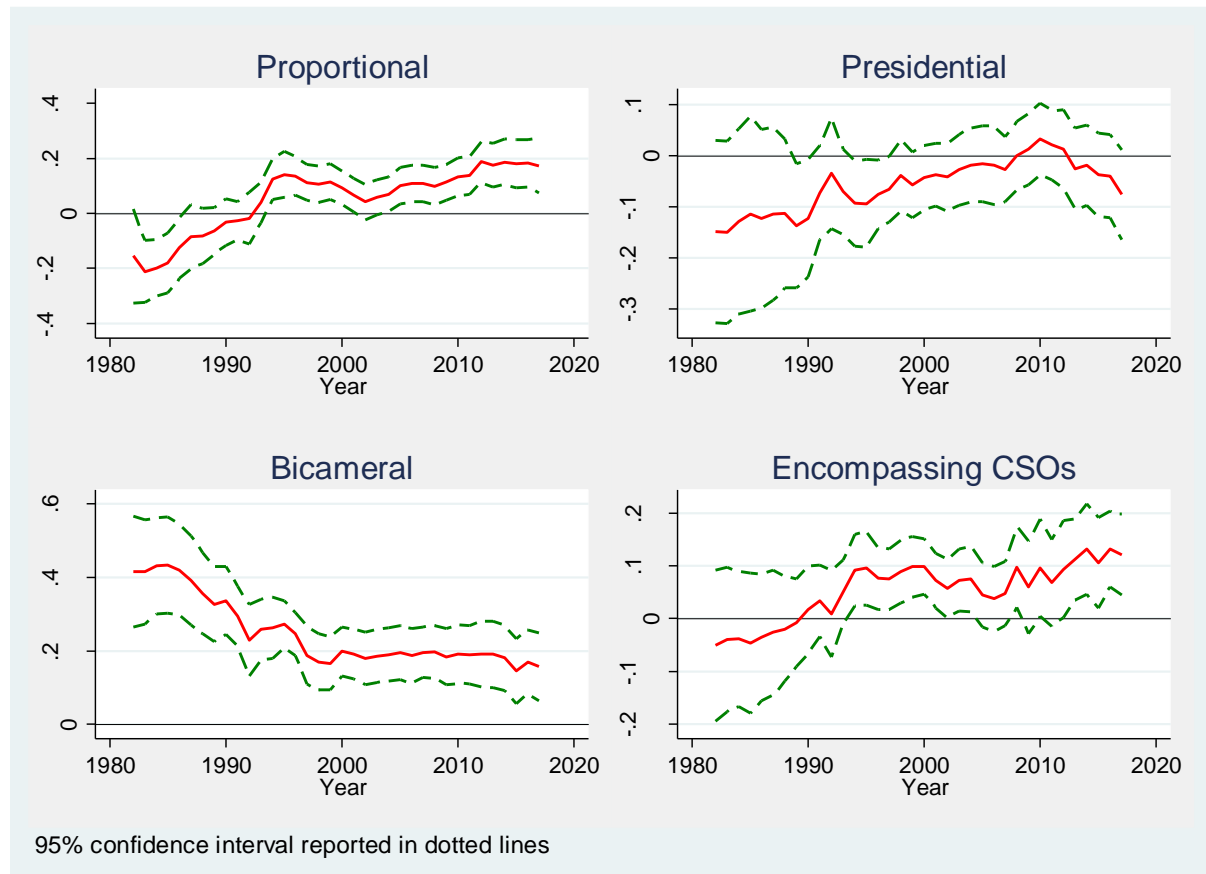
The main findings can be summarized as follows. Within the decreasing common trend shown above in the period 1982-2017, the presence of a proportional electoral rule and encompassing CSO determined an increasing commitment in public research with respect to other countries. These countries increasingly departed from the generalized negative trend. By contrast, the positive effect of bicameralism has decreased up to the end of nineties and then it has stabilized. Finally, the form of government (presidential versus parliamentary) did not matter much in moderating the negative trend of *public R&D*.

4.4 Some robustness checks

This last section reports the results of some robustness checks to assess whether the choices made in building the estimation sample have an influence on the main findings presented in section 4.2.

Since we were interested in the institutional characteristics that are conducive to higher *Public R&D* rather than the more general link between growth and democracy (e.g. Acemoglu et al., 2019), we have included in our sample countries that are usually classified as autarchies. We therefore re-run our full specification excluding those countries with the lowest average scores of the electoral

democracy index (v2x_polyarchy) available in V-DEM.[12] According to this rule, China, Russia, Singapore and Turkey (10% of countries) are excluded from the estimation sample. Results are reported in the first column: all the institutional variables remain unchanged, with the only exception of presidential form of government that turns out to be not statistically significant.

Tab 4: Robustness checks, two-way fixed effects regressions

	Autarchies	Few observations	Public R&D not interpolated
Per capita income	0.002**	0.000	0.001
	(0.001)	(0.001)	(0.001)
Older population	0.016***	0.016***	0.015***
	(0.004)	(0.004)	(0.004)
Proportional	0.037*	0.044**	0.050**
	(0.021)	(0.018)	(0.020)
Presidential	0.006	-0.031	-0.037*
	(0.028)	(0.021)	(0.021)
Bicameral	0.225***	0.209***	0.214***
	(0.025)	(0.023)	(0.023)
Encompassing CSOs	0.063***	0.069***	0.055***
	(0.014)	(0.013)	(0.014)
Check and balances	0.047	-0.065	-0.059
	(0.072)	(0.051)	(0.053)
Expenditure rule	-0.053***	-0.050***	-0.060***
	(0.014)	(0.014)	(0.015)
Constant	0.226**	0.360***	0.362***
	(0.109)	(0.082)	(0.086)
Observations	1,135	1,148	1,058
R-squared	0.803	0.800	0.817
RMSE	0.108	0.107	0.105

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The regressions include country and time fixed effects.

Our sample grows over time with the entry of new countries for which *Public R&D* become available. Many countries entered back in the eighties, and some others later. We run our full specification excluding those countries with less than 20 years of observations – namely Chile, China, Lithuania, Luxembourg and South Africa – to control whether the inclusion of countries with fewer temporal observations may influence our main results. Results are reported in the second column of table 4 - virtually unchanged.

Finally, we assess whether the choice of interpolating our dependent variable to avoid gaps and maximize the number of observations significantly affects the estimated relationships. The results, reported in the last column of table 4, suggest that this is not the case.

All-in-all, the set of robustness checks makes us quite confident about the soundness of our results.

---

[12] This index is computed as a weighted average of different indexes measuring freedom of association thick, clean elections, freedom of expression, elected officials, and suffrage. See Coppedge et al. (2019) for more details.

5. Conclusions

The broad consensus about the benefits of public research is at odds with the fact that it is in general declining, despite following different patterns across countries. This paper is a first attempt to answer to the question, so far under-explored, "why do countries exhibit different patterns of public R&D investment"? By relying on political economy literature, we frame investment in public research as a political choice depending on the political institutions in which it is made.

We find robust evidence of a significant relationship between our three political institutions, namely form of government, electoral rule and bicameralism, and the engagement of governments in R&D. We also find a strong and positive role for encompassing civil organizations in determining public research. Our results can be discussed in relation to the main theoretical arguments of comparative political theory and political economy. Our evidence is consistent with a systematic better performance of the so-called *consensual* democracies versus *majoritarian* democracies; the former are characterized by dispersion of power among parties, while the latter are characterized by a concentration of power in the hand of the executive power. According to Lijpjart (1999) consensual democracies are particularly efficient to manage diverse and plural society, thanks to the attention to the balance of power.[13]

Our findings suggest that consensual democracy – i.e. proportional electoral rules, parliamentary systems with bicameralism legislature - perform better also in terms of committing on policies that benefit the society at large as well in the long run. As such, these types of institutional systems show a lower intertemporal discount rate when setting the political agenda; by giving more importance to the future, they mitigate problems of short-termism. As such, they might be better off in reconciling the needs of economic growth and development to the constrains of policy making.

Our characterization of consensual democracy is based not only on political institutions but also on the involvement of the civil society. We show that when power is distributed outside formal political institutions to include encompassing civil society organizations, forward commitment in public policy is further boosted. This casts some doubts about the long-term sustainability of the neoliberal approach that has downplayed the role of intermediate bodies in society, sometime emphasizing their corporative interests as in the case of unions.

Doubts can be raised concerning the positivistic view that more public research is always desirable. In fact, the impact of public-funded research on the society depends on several contextual factors; there is a qualitative aspect that is not captured by our analysis. Scientists are organized in communities with relative power, and hence the funding of research is not neutral, and it is not free of distortions in the allocation process.

Finally, we believe to have shown a conceptualization and some preliminary results about a new and promising avenue of research, by bringing public research within the sphere of public policy and political economy. This paper is just a fist attempt which aims to capture the relationship between political institutions and the funding of research at the institutional level. Further attention should be

---

[13] It is worth noting that the Italian school of public finance introduced with De Viti De Marco a distinction that become central between the Monopolistic State and the Cooperative State that would result in a different fiscal outcome depending, in turn, on different political processes of choice. From here it follows the importance of the constitutions in determining the type of state.

devoted to delve into the very political mechanisms that drive the allocation process of public research across different fields and projects. In addition, it would be interesting to extend the current model to other types of public expenditure, e.g. in the health sector of in pension schemes, to check the reach of it.

Can we derive some policy implications? Within the well-established trade-off between decision making and representation in politics, in recent years the pendulum of reforms has been swinging towards the former. The rationale is that fast and effective decision-making institutional settings make government better equipped to respond to the current economic global environment. Our results challenge this view. Institutions that maximise representation, proportional systems with bicameralism, favour long-term investing which, in turn, might improve the capacity of economic systems to cope with major shocks. Hence, the trade-off between institutions that favour broad and consensual representation and resilience may be a fallacious one.

Secondly, the presence of intermediate actors, such as unions, industry associations and other stakeholders in political life, can be viewed as a resource in the political process when their interest are broad and encompassing a large fraction of the society. The dismantling of interest groups, based on the assumption that they have a systematic negative effect on the economic system, should be reconsidered in the light of the possible, and desirable, alignment of their incentives towards long-term investment and economic growth.

All-in-all, we feel safe in providing a warning to those policy makers that are tempted by majoritarian-like reforms attracted by the speed of the decision-making process. In the balance of the choice, we would add the fact that majoritarian-like political institutions seem to discourage forward commitment and exacerbate short-termism in policymaking, ultimately hampering resilence and long-term prosperity.

References

Acemoglu, D., Naidu, S., Restrepo, P. and Robinson J.A. (2019). Democracy Does Cause Growth. *Journal of Political Economy*, 127(1):47-100.

Akçomak, İ.S. and ter Weel, B. (2009). Social capital, innovation and growth: Evidence from Europe. *European Economic Review*, 53(5):544-567.

Akkermans, D., Castaldi, C. and Los, B. (2009). Do 'liberal market economies' really innovate more radically than 'coordinated market economies'? Hall and Soskice reconsidered. *Research Policy*, 38: 181-191.

Anand, P. and Poggi, A. (2018). Do Social Resources Matter? Social Capital, Personality Traits, and the Ability to Plan Ahead. *Kyklos*, 71:343-373.

Andriani, L. and Christoforou, A. (2016). Social capital: a roadmap of theoretical and empirical contributions and limitations. *Journal of Economic Issues*, 50(1):4-22

Andriani, L. and Sabatini, F. (2015). Trust and prosocial behaviour in a process of state capacity building: the case of the Palestinian territories. *Journal of Institutional Economics*, 11(4):823–846.

Archibugi, D., Filippetti, A. and Frenz, M. (2020). Investment in innovation for European recovery: a public policy priority. *Science and Public Policy*, 47(1):92-102.

Archibugi, D. and Filippetti, A. (2018). The retreat of public research and its adverse consequences on innovation. *Technological Forecasting and Social Change*, 127: 97-111.

Archibugi, D. and Filippetti, A. (2015). Knowledge as Global Public Good. In Archibugi, D. and Filippetti, A. (Eds.), Handbook of Global Science, Technology and Innovation. Wiley, Oxford, pp. 479-503.

Arrow, K. (1962). Economic Welfare and the Allocation of Resources for Invention. In: Nelson, R.R. (Ed.), The Rate and Direction of the Inventive Activity: Economic and Social Factors. Princeton University Press, Princeton, pp. 609-626.

Batinti, A., Andriani, L. and Filippetti, A. (2019). Local government fiscal policy, social capital and electoral payoff: evidence across Italian municipalities. *Kyklos*, 72:503-526.

Batinti, A. and Congleton, R.D. (2018). On the codetermination of tax-financed medical R&D and healthcare expenditures: Models and evidence. *European Journal of Political Economy*, 54: 175-188.

Bednyagin, D. and Gnansounou, E. (2012). Estimating spillover benefits of large R&D projects: Application of real options modelling approach to the case of thermonuclear fusion R&D programme. *Energy Policy*, 41:269-279.

Becker, B. (2015). Public R&d Policies and Private R&D Investment: A Survey of the Empirical Evidence. *Journal of Economic Surveys* 29:917-942.

Blanchard, O. and Wolfers, J. (2000). The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence. *Economic Journal*, 110 (March): C1-C33.

Blankart, C.B. and Koester, G.B. (2006). Political economics versus public choice. *Kyklos*, 59(2):1-29.

Blume, L., Müller, J., Voigt, S. and Wolf, C. (2009). The economic effects of constitutions: replicating—and extending—Persson and Tabellini. *Public Choice*, 139:197–225.

Bradbury, J.C. and Crain, W.M. (2002). Bicameral legislatures and fiscal policy. *Southern Economic Journal*, 68(3):646–659.

Buchanan, J.M. and Tullock, G. (1962). The calculus of consent. Logical Foundations of Constitutional Democracy. University of Michigan press: Ann Arbor.

Budina, N.T., Weber, A. and Kinda, T. (2012). Fiscal Rules in Response to the Crisis: Toward the "Next-Generation" Rules: A New Dataset. IMF Working Paper No. 12/187.

Ciriaci, D., Grassano, N. and Vezzani, A. (2019). Regulations and location choices of top R&D investors worldwide. *Structural Change and Economic Dynamics*, 49:29-42.

Congleton, R.D., Batinti, A. and Pietratonio, R. (2017). The electoral politics and the evolution of complex healthcare systems. *Kyklos*, 70, 483–510.

Congleton, R.D. (2003). On the merits of bicameral legislatures: Policy stability within partisan polities. *Jahrbuch für Neue Politische Ökonomie*, 22:29–49.

Coppedge, M., Gerring, J., Knutsen, C.H., Lindberg, S.I, Teorell, J., Altman, D., Bernhard, M., Fish, M.S., Glynn, A., Hicken, A., Lührmann, A., Marquardt, K.L., McMann, K., Paxton, P., Pemstein, D., Seim, B., Sigman, R., Skaaning S-E., Staton, J., Cornell, A., Gastaldi, L., Gjerløw, H., Mechkova, V., von Römer, J., Sundtröm, A., Tzelgov, E., Uberti, L., Wang, Y-t., Wig, T. and Ziblatt, D. (2019). V-Dem Codebook v9. Varieties of Democracy (V-Dem) Project.

Crescenzi, R., Gagliardi, L. and Percoco, M. (2013). The 'bright' side of social capital: How 'bridging' makes Italian provinces more innovative. In Crescenzi, R. and Percoco, M. (Eds.), Geography, Institutions and Regional Economic Performance. Springer-Verlag, Berlin Heidelberg, pp. 143–164.

David, P.A., Hall, B.H. and Toole, A.A. (2000). Is public R&D a complement or substitute for private R&D? A review of the econometric evidence. *Research Policy*, 29:497–529.

Dosi, G. (1982). Technological Paradigms and Technological Trajectories. *Research Policy*, 11(3): 147–162.

Dosi, G. and Stiglitz, J.E. (2014). The role of intellectual property rights in the development process, with some lessons from developed countries: an introduction. In Cimoli M., Dosi G., Maskus K.E., Okediji R.L., Reichman J.H., Stiglitz J.E. (Eds.), Intellectual property rights: Legal and economic challenges for development. Oxford University Press, Oxford, pp. 1-55

Filippetti, A. and Guy, F. (2020). Labor market regulation, the diversity of knowledge and skill, and national innovation performance. *Research Policy*, 49(1):1-14.

Foray, D., Mowery, D.C. and Nelson, R.R. (2012). Public R&D; and social challenges: What lessons from mission R&D programs? *Research Policy*, 41(10): 697-1702.

Freeman, C. (1995). The 'National System of Innovation' in historical perspective. *Cambridge Journal of Economics*, 19(1): 5-24.

Freeman, R. and Van Reenen, J. (2009). What if Congress doubled R&D spending on the physical sciences? *Innovation Policy and the Economy*, 9(1): 1-38.

Garrì, I. (2010). Political short-termism: a possible explanation. *Public Choice,* 145:197-211.

González-Ricoy, I. and Gosseries, A. (2016). Institutions for Future Generations. Oxford University Press, Oxford.

Hall, P.A. and Soskice, D. (eds.) (2001). Varieties of Capitalism: The Institutional Foundations of Comparative Advantage, Oxford University Press, Oxford.

Henisz, W.J. (2000). The Institutional Environment for Economic Growth. *Economics & Politics*, 12(1): 1-31.

Holm, J.R., Lorenz, E., Lundvall, B.Å. and Valeyrez, A. (2010). Organizational learning and systems of labor market regulation in Europe. *Industrial and Corporate Change*, 19:1141-1173.

Huber, E., Ragin, C. and Stephens, J.D. (1993). Social democracy, Christian democracy, constitutional structure, and the welfare state. *American Journal of Sociology*, 99(3):711–749.

Kaiser, U. (2002). Measuring knowledge spillovers in manufacturing and services: an empirical assessment of alternative approaches. *Research Policy* 31: 125-144.

Knack, S. and Keefer, P. (1997). Does Social Capital Have an Economic Payoff? A Cross-Country Investigation. *Quarterly Journal of Economics,* 112(4):1251-1288.

Lijphart, A. (2012). Patterns of democracy: Government forms and performance in thirty-six countries. Second Edition, Yale University Press, New Haven and London.

Lizzeri, A. and Persico, N. (2001). The provision of public goods under alternative electoral incentives. *American Economic Review,* 91(1): 225-239.

Lundvall, B.Å., Johnson, B., Andersen, E.S. and Dalum, B. (2002). National systems of production, innovation and competence building. *Research Policy*, 31(2): 213-231.

Mokyr, J. (1998). The political economy of technological change. In Kristine, B. and Berg, M. (Eds.), Technological revolutions in Europe: historical perspectives. Edward Elgar, Cheltenham, pp. 39-64.

Mokyr, J. (1992). The lever of riches: Technological creativity and economic progress. Oxford University Press, Oxford.

Mueller, D.C. (2003). Public Choice III. Cambridge University Press, Cambridge.

Nelson, R.R. (Ed.). (1993). National innovation systems: a comparative analysis. Oxford University Press, New York.

Nelson, R.R. (1959). The Simple Economics of Basic Scientific Research. *Journal of Political Economy,* 67(3): 297–306.

NSF (2007). Impact of Proposal and Award Management Mechanisms. Final Report to the National Science Board. Washington, DC: National Science Foundation.

Olson, M. (1982). The Rise and Decline of Nations: Economic Growth, Stagflation, and Social Rigidities. Yale University Press, New Haven and London.

Olson, M. (1965). The Logic of Collective Action. Public Goods and the Theory of Groups. Harvard University Press, Cambridge, MA.

Persson, T. and Tabellini, G. (2004). Constitutions and economic policy. *Journal of Economic Perspectives*, 18(1):75-98.

Persson, T. and Tabellini, G. (2002). Political Economics: Explaining Economic Policy. The MIT Press, Cambridge, MA.

Pierce, J.C., Lovrich, N.P. and Budd, W.W. (2016). Social capital, institutional performance, and sustainability in Italy's regions: Still evidence of enduring historical effects? *The Social Science Journal*, 53(3):271-281.

Pisano, G.P. and Shih, W.C. (2009). Restoring American Competitiveness. *Harvard Business Review*, 87(7/8):114-125.

Putnam, R.D. (1993). Making democracy work: civic traditions in modern Italy. Princeton University Press, Princeton.

Reinert, E.S. (1999). The role of the state in economic growth. *Journal of Economic Studies*, 26(4/5), 268-326.

Rodrik, D. (1996). Why do more open economies have bigger governments? National Bureau of Economic Research, Working Paper No.5537.

Rosenberg, N. (1982). Inside the black box: Technology and Economics. Cambridge University Press, Cambridge.

Schneider, A.L. (1987). Coproduction of Public and Private Safety: An Analysis of Bystander Intervention, 'Protective Neighboring', and Personal Protection. *Western Political Quarterly*, 40(4):611-630.

Taylor, M.Z. (2016). The politics of innovation: Why some countries are better than others at science and technology. Oxford University Press, New York.

Tullock, G. and Palda, K.F. (1994). The new federalist. Fraser Institute Vancouver.

Voigt, S. (2011). Positive constitutional economics II—a survey of recent developments. *Public Choice*, 146(1-2): 205-256.

Zak, P.J. and Knack, S. (2001). Trust and Growth. *The Economic Journal*, 111(470):295-321.

Appendix

Table A.1: List of countries included in the analysis and first year of inclusion

Australia (1981)	Iceland (1981)	Portugal (1982)
Austria (1981)	Ireland (1981)	Romania (1995)
Belgium (1983)	Israel (1991)	Russia (1994)
Canada (1981)	Italy (1981)	Singapore (1994)
Chile (2007)	Japan (1981)	Slovak Republic (1992)
China (2000)	Korea (1995)	Slovenia (1993)
Czech Republic (1995)	Latvia (1995)	South Africa (2001)
Denmark (1981)	Lithuania (2000)	Spain (1981)
Estonia (1998)	Luxembourg (2000)	Sweden (1981)
Finland (1981)	Mexico (1990)	Switzerland (1981)
France (1981)	Netherlands (1981)	Turkey (1990)
Germany (1981)	New Zealand (1981)	United Kingdom (1981)
Greece (1981)	Norway (1981)	United States (1981)
Hungary (1991)	Poland (1994)	

Note: the inclusion in the analysis is dependent on the availability of public R&D expenditure data

Table A.2: Descriptive statistics

	Average	Median	Standard deviation	Minimum	Maximum
Public R&D	0.571	0.553	0.232	0.110	1.245
General public expenditures	18.357	18.693	4.423	7.515	38.452
Per capita income	24.389	21.417	15.561	0.354	107.641
Older population	13.187	13.801	4.218	3.883	27.109
Proportional	0.623	1	0.485	0	1
Presidential	0.390	0	0.488	0	1
Bicameral	0.521	1	0.500	0	1
Encompassing CSOs	0.388	0	0.487	0	1
Check and balances	0.820	0.897	0.209	0.040	0.984
Expenditure rule	0.274	0.000	0.446	0	1

Table A.3: Correlations among variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1. Public R&D	1									
2. General public expenditures	0.396	1								
3. Per capita income	0.321	0.013	1							
4. Older population	0.224	0.442	0.314	1						
5. Proportional	-0.161	0.241	-0.013	0.097	1					
6. Presidential	0.035	-0.220	-0.051	-0.175	-0.026	1				
7. Bicameral	0.037	-0.158	-0.027	0.069	-0.214	0.078	1			
8. Civil society	0.258	0.325	-0.131	0.116	0.298	0.035	-0.052	1		
9. Check and balances	0.302	0.401	0.238	0.461	0.007	-0.168	0.036	0.175	1	
10. Expenditure rule	0.251	0.149	0.499	0.234	-0.176	-0.024	-0.011	-0.093	0.176	1

Figure A.1: Public R&D expenditures by country

Graphs by ISO3 country code