British Journal of Political Science (2018), 49: 1, 1–16
doi:10.1017/S0007123418000431

British Journal of Political Science

ARTICLE

The British Academy Brian Barry Prize Essay Justifying Public Funding for Science

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(Received 31 January 2018; revised 12 September 2018; accepted 19 September 2018; first published online 17 October 2018)

Abstract
Public funding for science is increasingly coming under attack. This article explores the normative force of these charges, and the arguments that are available to counter them. It examines two justifications of state support for science: Vannevar Bush's vision of the universal material benefits of scientists pursuing basic research and John Rawls's liberal justification of science funding as a voluntary public good. It argues that both accounts neglect the important political impact of scientific research and its status as the source of knowledge for the modern state. The article then traces the implications of the political role of science for the appropriate forms of democratic input into funding decisions.

Keywords science; democracy; taxation; liberalism; public goods

'Was duck penis study an appropriate use of taxpayer money?' ran a headline from conservative US media outlet Fox News in 2013. The associated article attacked a US government-funded animal behavior study on duck genitalia conducted at Yale University as a wasteful use of federal money. Two years earlier, another scientific study had been held up for ridicule: 'Your tax dollars at work: shrimp on treadmills' (Fox News 2011). Although the immediate target of the attack was different, the main goal was the same: to criticize the National Science Foundation for wasting hundreds of thousands of taxpayer dollars in support of scientific projects that were supposed to seem obviously trivial to a layperson. To make the point more vivid, the earlier story included a rather fascinating video from the study, featuring – what else? – a shrimp exercising on a miniature treadmill, while a scientist took notes on its performance.

Mocking randomly selected examples of 'silly' science has become a standard rhetorical tool for US Republicans who want to complain about the federal government's wastefulness (Greenfieldboyce 2011). In a new line of attack, the Trump administration proposed major cuts to all federal programs supporting climate change research on the grounds that it clashed with the country's energy needs and economic vitality (Rice and King 2017; Waldman 2017). This time, scientists were charged with actively harming American economic interests. Since both the level and distribution of public funding for basic scientific research is increasingly coming under attack, it is important to consider what normative force, if any, these charges may possess, and what arguments are available to counter them. This requires being clear about the justifications offered for supporting science with public funds, and what these justifications imply about the degree and kind of political intervention that is appropriate in decisions about the distribution of funds. Justification becomes necessary when the value of an activity can no longer be taken as self-evident. In the second half of the twentieth century, research in the natural sciences consistently enjoyed high levels of public support and financial investment from the state. Thus while political theorists dedicated considerable attention to defending funding for the arts, the

humanities and environmental preservation in the face of low or declining public support (Collini 2012; Munoz-Dardé 2013; Nussbaum 2016), the grounds for funding science received little philosophical scrutiny. This article seeks to fill this gap.

It proceeds by examining two different justifications offered in support of funding science. I show why they are inadequate, and then sketch a third line of justification that accounts for the neglected political implications of science funding. The first section focuses on Vannevar Bush's influential arguments from the 1940s, which laid the foundations for an ambitious program of publicly funded science in the United States. Bush argued that universal public benefits would follow from basic scientific research, and that these benefits would be best realized if scientists were given a high degree of autonomy to pursue their curiosity. The second section contrasts Bush's argument with the liberal justification provided by John Rawls. Rawls did not play a key role in shaping the national funding regime for science, but he provided one of the most influential normative accounts of how a liberal democratic state should treat the provision of public goods. His account implicitly rejected elitist approaches such as Bush's by arguing that state support for science (and art) must be based on the benefit principle, which would ensure that each person paid only for the benefits that they wanted. Despite their differences, both of these accounts failed to take into account the important political implications of scientific research: its role in determining political problems and their possible solutions, and its status as the authoritative source of knowledge for the modern state. In the third section, I will argue that the close connection between scientific inquiry and truth, and the special link between science and policy in the modern state, provide additional grounds for justifying the public funding of science beyond those that apply to the public provision of roads, bridges, infrastructure or even art. I will end by discussing which kinds of political input into funding decisions would be appropriate once we recognize the political consequences of funding science.

Vannevar Bush and a Vision of the Common Good

At the end of World War II, President Roosevelt asked the engineer and science administrator Vannevar Bush to develop a new vision for how the government might support scientific research in the post-war period.[1] Bush's report, called *Science: The Endless Frontier,* became the most influential document setting out the role that science could play in a large modern democracy (Kleinman 1995). Bush's argument had two key features. The first feature was the justification of public support for science based almost entirely on expected material benefits.

> Advances in science when put to practical use mean more jobs, higher wages, shorter hours, more abundant crops, more leisure for recreation, for study, for learning how to live without the deadening drudgery which has been the burden of the common man for ages past. Advances in science will also bring higher standards of living, will lead to the prevention or cure of diseases, will promote conservation of our limited national resources, and will assure means of defense against aggression (Bush 1960[1945], 10).

This was a clever strategy for addressing the dilemma facing science at the end of the war. The American public appreciated the role that scientists had played in winning the war, but lacked a non-military vision that could justify continuing to spend large amounts of public funds on abstract scientific research. At the same time, cutting-edge science had become increasingly dependent on the continuation of large amounts of public funding, as military investment in science during the war had changed the nature and scope of scientific research. Bush's challenge was to come up with a persuasive narrative for what science could do to improve the lives of ordinary citizens in order to ensure continued public investment in basic research.

[1]For more background on the debates around science in this period, see Kevles 1995[1978]; Kleinman 1995; Mann 2000; Savage 1999.

The second key tenet of the report was the necessity of granting scientists a high degree of autonomy from political processes and giving them control over the distribution of public funds.[2] Bush claimed that the public would benefit most from science if scientists were left free to pursue abstract research into areas that interested them: 'Scientific progress on a broad front results from the free play of intellects, working on subjects of their own choice, in the manner dictated by their curiosity for exploration of the unknown' (1960[1945], 12).

These two features, which defined the structure of science policy for the next several decades, gave science funding an unusual status among public goods. Although spending on science was justified on the basis of its expected public benefits, the public had little say in how these benefits would come about. This special status faced a justificatory challenge: its plausibility depended on establishing a link between the public good and scientists pursuing their curiosity, but it was not obvious what could supply this link.

Any account that claims that some means will be effective in furthering public welfare must either presuppose knowledge of what constitutes it or include a procedure for how it should be determined. Bush's report developed a very clear and concrete vision of what would constitute the public good for America in the post-war years: full employment, the production of goods and services to raise the standard of living, cheaper and better products to give the country an advantage in international trade, technological developments to increase agricultural productivity and medical advances to cure disease. In short, a materialist conception of progress that emphasized benefits from rapid economic growth and increased productivity. While this was certainly a vision of *common* good, in the sense that it claimed the universal desirability of this bundle of material goods, it pushed forward an elite-driven vision instead of allowing a democratic one.

It is significant that Bush rested his argument on a particular conception of public welfare, rather than admitting the inherently political and contested nature of its determination. In doing so, he was trying to avoid two alternative lines of argument. The first was the democratic line that the public interest should be determined through the appropriate political procedures and should be responsive to the wishes and values of the public, whatever they might be. This would have paved the way for more political input into the direction of scientific research as well as the total level of funding, so it is clear why Bush wanted to avoid it. The second alternative argument was to maintain that scientists should be given the authority to determine what would be in the public interest because of their superior wisdom and knowledge. This would have been an explicitly anti-democratic line, but it would also have been philosophically more coherent than Bush's position because it provided a straightforward justification for giving full autonomy to scientists. Instead, Bush put himself in the position of having to defend the bold and untested empirical claim that abstract scientific research would be the best way to maximize the public benefits he had described.

Since no system of public funding for basic research of a comparable scale had ever been tried before, it was impossible to provide empirical evidence to support this claim. And Bush did not provide an argument linking scientific research to specific outcomes. Instead, his main point was that whatever people might want from science, basic research would be the way to get it (Kitcher 2001). Scientists would distribute funds among projects with an eye to solving important puzzles, contributing to scientific progress, stimulating further research or opening up new possibilities for future inquiry. Public benefits would follow if scientists simply pursued the most significant advances and produced the most important breakthroughs. The argument mimicked the classical economists' argument for the free pursuit of private profit: just as economists claimed that society as a whole benefited from the pursuit of profit by individual businessmen, so too would society benefit from individual scientists' free pursuit of their curiosity.

[2]See Douglas (2009) and Kitcher (2001) for recent arguments in favor of this ideal.

Given the high level of trust in science and scientists after the war, this argument met little resistance. But public acceptance does not equate to normative merit; it is important to examine what could justify it. There may not have been empirical evidence, but there were influential philosophical arguments about scientific progress that had clear implications for the distribution of funds. Bush's claim that the greatest scientific progress would be made if scientists were free to pursue their interests followed a theory of scientific progress developed by the scientist-turned-philosopher Michael Polanyi.

In a series of articles in the 1940s, Polanyi traced scientific progress to the activities of a community of scientists sharing methods and standards, left free from political interference (Polanyi 1941a; Polanyi 1941b; Polanyi 1945a; Polanyi 1945b).[3] He developed the argument using an analogy between scientists and actors in a free market economy.

> [The] self-co-ordination of independent initiatives leads to a joint result which is unpremeditated by any of those who bring it about. Their co-ordination is guided as by 'an invisible hand' towards the joint discovery of a hidden system of things. Since its end-result is unknown, this kind of co-operation can only advance stepwise, and the total performance will be the best possible if each consecutive step is decided upon by the person most competent to do so (Polanyi 1962, 55).

Two key epistemic points supported this argument. The first was the indeterminacy of scientific research. Polanyi maintained that because it was impossible to predict where the most significant scientific advances would come from, any attempt by a funding committee to direct the course of science toward a specific purpose would fail. This was similar to Hayek's (1945) argument against central planning on the basis of informational limitations. Just as Hayek maintained that the insurmountable information problem facing central planners showed the futility of government intervention in the economy, Polanyi argued that the indeterminacy of science meant that government interference in funding decisions would be pointless. His alternative was to leave it all to experts: 'So long as each allocation follows the guidance of scientific opinion, by giving preference to the most promising scientists and subjects, the distribution of grants will automatically yield the maximum advantage for the advancement of science as a whole' (Polanyi 1962, 60).

The second point that supported the argument was a cumulative view of scientific progress. Polanyi subscribed to the traditional view of science moving incrementally toward a complete picture of the truth. He compared the scientific enterprise to a giant jigsaw puzzle, with each scientist carefully watching the moves of others in order to make new moves that became possible as a result of earlier ones (Polanyi 1962). This account assumed a fundamental unity in science, such that all research fits together to form a coherent whole, which corresponds to the truth about the physical laws of the universe. The selection of research questions is thus not really an open choice: The scientist's task is to continue earlier work in the area and fill in the gaps in existing knowledge. The significance of a research agenda comes from the role of the particular finding in contributing to the completion of the puzzle.[4] Science benefits society simply by making rapid progress on the puzzle.

The indeterminacy argument is hard to dispute, but it does not support autonomy for scientists on its own. It simply shows the difficulty of directing the research enterprise toward predictable outcomes. Indeterminacy could just as easily lend support to a distribution scheme that allocates funds equally among all projects, or one that determines allocation randomly. Polanyi's argument for scientific autonomy depends on his second claim that scientific progress is a linear and cumulative movement toward a unified picture of truth. This view implies that at any given moment, there are only a few possibilities for new discovery, which are determined by

[3]More developed versions of this view can be found in later works such as Polanyi (1951) and Polanyi (1962).

[4]See Dupré (2004) and Kitcher (2001) for more on this philosophical position and its weaknesses.

the most recent discoveries in a particular area. The next move in the puzzle is fairly definite, and only scientists who have been closely following the work of other scientists can know what it is. Central planners who want to direct research toward the solution of pressing social problems will simply not be able to tell which areas are likely to yield discoveries. This justifies giving autonomy to scientists over decisions about the allocation of funds.

However, Thomas Kuhn radically challenged this picture of linear and cumulative scientific progress in *The Structure of Scientific Revolutions* (1962). Kuhn affirmed Polanyi's description of everyday scientific research as an esoteric puzzle-solving activity, but rejected the claim that each problem solved was one small step toward a full picture of truth. He argued instead that the ordinary activities of scientists, which he called normal science, should be understood as advancing a particular paradigm – a set of shared methods, standards and accumulated knowledge. According to Kuhn, the puzzles selected by scientists are significant only in relation to the paradigm, and do not correspond to an external standard of truth. The most significant and radical discoveries take place during periods when the paradigm becomes unable to solve important puzzles and breaks down. It is then replaced by a new paradigm in a dramatic event Kuhn called a scientific revolution. Normal science is still essential to significant discoveries, but only because it prepares the conditions that make a revolution possible. The revolution itself is unintended and strongly resisted by practitioners of the old paradigm, who want to defend their own methods and findings.

An important consequence of Kuhn's challenge was to undermine the intrinsic significance of scientists' everyday puzzles and thus also Polanyi's claim that scientists know best which problems are likely to produce significant discoveries. Kuhn nonetheless agreed with Polanyi that scientists must be left to pursue their puzzles – not because they knew where the next major breakthrough would come from, but because only a scientist working within a paradigm could detect the anomalies that would eventually lead to a revolution. Paradoxically, the necessary condition for radical and creative novelty turned out to be a scientific community that was rigidly controlled, esoteric and elitist.

The problem with this position was that it took for granted the continued emergence of alternative views capable of challenging a paradigm and precipitating a revolution, but did not explain why. In fact, Kuhn's own view implies that the scientific community is structured precisely to extinguish this possibility: he claimed that scientists working in a paradigm would do everything in their power to resist threats to their paradigm. It is therefore curious that he did not consider the possibility that they might succeed only too well and end up extinguishing radical innovation. The risk that normal science might stifle innovation is even more serious under a system of scientific research that depends heavily on the availability of funding. If scientists working in a paradigm have a high degree of autonomy over the distribution of funds, then the easiest way to defend the paradigm is to fund projects that develop it and not fund those that challenge it radically.

One of the most original contributions of Kuhn's *Structure* was to shift attention away from the lone individual following the scientific method and onto the dynamics of a community of scientists working with shared and unquestioned standards, norms and assumptions. Yet Kuhn's famous examples of scientific revolutions were all drawn from periods that preceded the emergence of a highly professionalized community of scientists with shared and strongly enforced norms. Innovators such as Copernicus, Newton, Lavoisier and Einstein, who overturned established scientific consensus, emerged in scientific contexts without a professional community with institutional tools for resisting new ideas. This mismatch between his examples and his conclusions makes it difficult to share Kuhn's belief that a closed community of specialists entrusted with complete control over funding decisions will continue to produce radical ideas that undermine its own shared assumptions and findings. The argument for giving scientists complete autonomy over funding decisions runs into difficulty when we consider the possibility that the process might develop in ways that would prevent rather than encourage the

free pursuit of ideas and the emergence of significant discoveries. If, as Kuhn's theory implies, a highly autonomous scientific community can use their control over funding to resist new ideas that might threaten existing paradigms, outside intervention may be necessary to ensure the continued possibility of radical challenges. I will return to this idea in the third section.

Rawls's Liberal Justification

So far, I have examined the philosophical underpinnings of Bush's argument for expansive state support for basic scientific research and a high degree of autonomy for scientists over the distribution of funds. Bush made his case on the basis of a specific and rather materialistic conception of progress and flourishing in post-war America. In this section, I explore the justifiability of relying on such a particular vision of the good to support public funding for science in a liberal democracy. After all, scientific research is not equally valuable to all citizens, and not all who value it do so for the instrumental reasons that Bush offered. Since dedicating large amounts of money to science will detract from other goods and services that the state could be providing, we must consider whether and when it is acceptable for a liberal state to fund an activity on the basis of a specific vision of the good. A promising way to address this question is to juxtapose Bush's arguments for science funding with liberal arguments for public funding that implicitly reject his approach. To this end, this section examines Rawls's arguments for funding science in a liberal society. Rawls mentioned science in just a few passages and invariably paired it with public funding for the arts, but these passages are well worth examining as they provide a striking contrast to Bush's approach. While Bush appealed to a specific conception of the good, at the heart of Rawls' argument was the idea that justifications for the public provision of certain kinds of goods should avoid appealing to any particular conception of what constitutes a public benefit.

In *A Theory of Justice,* Rawls divided state expenditures into two categories: those required by justice and those that are not (Rawls 1971, 62). The former is governed by his two principles of justice and applies to a society's background institutions, including legal definitions of property rights and a taxation scheme (1971, 29). These are necessary expenditures for sustaining a just basic structure in which all resulting distributions of income and wealth are also just. These expenditures are not subject to a popular vote; their imposition on all citizens is justified by the fact that they are a necessary cost of living in a just, mutually advantageous co-operative venture.[5] I am mainly interested here in Rawls' second category of public goods: those not required by justice.

Rawls pointed out that the requirements of justice might not extend to all public expenditures that citizens might wish to make. 'If a sufficiently large number of them find the marginal benefits of public goods greater than that of goods available through the market, it is appropriate that ways should be found for government to provide them' (Rawls 1971, 282). Since justice does not *require* the provision of these additional public goods, the principle regulating their provision would be solely that of benefit: individuals would be taxed in proportion to the benefits they receive. Interestingly, the only specific class of public goods he mentioned to illustrate this category was funding for the arts and sciences (Rawls 1971, 331).

Rawls gave more precise form to this requirement by appealing to Wicksell's unanimity principle, which held that for a public good to represent an efficient use of social resources, there must be a distribution of tax burdens that enjoys unanimous approval (Wicksell 1958[1896]). Decision makers adhering to this principle should therefore consider proposals for public goods together with alternative schemes for the distribution of tax burdens. Under such a scheme, those who would derive no benefit from the good would not be forced to pay, and the distribution of

[5]This contentious claim gave rise to the famous debate between Rawls and Nozick on whether the benefits derived from a co-operative enterprise could form the basis of an obligation to share its burdens (Nozick 1974).

burdens across individuals would track the value of the good for each person. Rawls adopted this principle and proposed the creation of a separate branch of government – the exchange branch – to apply this principle to particular decisions (Rawls 1971, 283).

Wicksell's unanimity principle is strange as a theory of public goods (Miller 2004, 131–3; Tuck 2008, 191–2). For one thing, it ignores the possibility that individuals might engage in strategic behavior or bargaining to secure better deals for themselves. Under this system, individuals have an incentive to misrepresent their preferences in order to secure a lower tax rate for goods that they would like to have provided. Since everyone has this incentive, implementing the unanimity principle would result in the under provision of public goods. This is a version of the classic free-rider problem. But even if we set aside the possibility of strategic behavior, the rule still allows for an extremely narrow scope for the state provision of non-justice goods. Specifically, it only allows the provision of goods that represent a Pareto improvement. Under this rule, the state cannot force anyone to subsidize goods she would not benefit from or to pay more for a good than its value to her. Only taxation packages under which no one would be a net loser would meet the unanimity requirement. The principle applies a narrow understanding of economic efficiency to the realm of public goods provision.

Rawls justified his adoption of this principle on the grounds that it would prevent the state from imposing unwanted burdens on people by appealing to perfectionist justifications that they did not share (Rawls 1971, 325). While expenditures required by justice are justified on the basis that everyone benefits from a just system, this logic cannot be applied to discretionary goods, which are defended by appealing to particular conceptions of the good. 'The principles of justice do not permit subsidizing universities and institutes, or opera and the theater on the grounds that these institutions are intrinsically valuable and those who engage in them are to be supported even at some expense to others who do not receive compensating benefits' (Rawls 1971, 332). He argued that funding discretionary goods on perfectionist grounds would be equivalent to forcing people to subsidize the private expenses of others.[6]

In *Justice as Impartiality*, Brian Barry rejected the view that a market-mimicking procedure must settle disagreements over public goods, and argued instead that such decisions should be settled through a democratic process (Barry 1995, 143–51). According to Barry's procedural account, decisions about the distribution of public goods must be treated the same way as any other political decision: people with different and incompatible preferences must reach an agreement about what to do. Appeals to specific conceptions of the good would be allowed as arguments in the deliberation, and the final decision would be made through a fair decision-making procedure, such as majority rule, agreed upon in advance.

Replacing unanimity with a majoritarian decision rule means that some people would be forced to subsidize goods that they did not want and would not benefit from. What justifies imposing tax burdens on the minority in these cases is not the intrinsic value of the good, but the fact that its provision is agreed upon through a fair decision procedure, which gives no special advantage to any conception of the good. This, in turn, is justified on the basis of the overall desirability of a system that allows individuals to cross-subsidize public goods for others: I subsidize your football stadium in return for your subsidizing my opera house. As long as each citizen has a reasonable chance of finding herself in the majority some portion of the time, everyone has reason to prefer this system since it will supply more of the goods that each person desires.[7]

[6]This became a fundamental tenet of liberal conceptions of state funding. In the 1990s, when US conservatives were attacking government funding for the National Endowment of the Arts, there was a lively debate among liberal theorists on whether public support for the arts could be justified based on a liberal conception of the state, assuming that support for 'high' art went against the preferences of the majority. Most theorists concluded that it was very difficult to do so. On this very interesting debate, see Brighouse (1995); Carroll (1987); Dworkin (1985, 225); Feinberg (1994).

[7]This is obviously an imperfect system. There might well be a problem with persistent minorities, who never get any of their desired goods. Miller points out that in an earlier work, Barry suggested that a majoritarian decision rule would be

Rawls endorsed a similar position in *Political Liberalism* and *Justice as Fairness: A Restatement* (Rawls 1996, 214; Rawls 2001, 151–2). While he maintained his earlier distinction between goods that concern 'constitutional essentials and the requirements of justice' and those that do not, he argued in these later works that the provision of non-justice goods could be decided by a democratic vote, rather than through unanimity. With the requirement of justice already in place, citizens could try to persuade each other of their preferences over public goods using arguments drawn from their comprehensive doctrines. Rawls was reluctant to classify many goods in the non-justice category, but science and art remained paradigm cases: 'Fundamental justice must be achieved first. After that, a democratic electorate may devote large resources to grand projects in art and science if it so chooses' (Rawls 2001, 152).

Rawls did not elaborate on the particular arguments that individuals could make in favor of funding science. As long as these arguments do not derive from claims about justice, their content is irrelevant to his structure of justification. Bush's appeal to the necessity of basic scientific research for economic development, full employment and progress would be equally acceptable as appeals to the intrinsic value of knowledge and understanding. His justification did not discriminate between the content of particular conceptions of the good and particular accounts of benefit. This framework could accommodate a vision such as Bush's if most individuals were convinced of the desirability of such a vision of public welfare and of the role of abstract science in achieving it. But this view must compete in the political realm with rival views such as those that defend a more targeted and applied science or those that claim the state need not support science at all.

This line of argument will naturally struggle to provide normative grounds for the continued provision of public goods in cases where most individuals do not want the benefits and do not believe the activity is intrinsically valuable. This difficulty has plagued liberals in their attempts to defend state support for the arts against conservatives attacking it on the grounds that it wastes money and encourages highbrow or offensive art.[8] How might a liberal argue against the charge that certain scientific studies are wasteful? One possible response is to point out the overall advantages of a system of basic research that involves funding many esoteric and seemingly trivial projects. Since we cannot know in advance which projects will yield the most innovative discoveries, it is reasonable to diversify funding. Even if most projects turn out to be dead ends, the system can be justified by the significant advances made in some areas. Instead of scrutinizing each project on the basis of whether it contributes to the desired public benefits, this approach argues that we should judge the system as a whole.

A second possible defense shows how particular studies are in fact indirect means of achieving the desired public benefits. Requiring grant applications to outline expected public benefits encourages scientists to justify their work in terms of imagined downstream benefits even where these may not be obvious. The scientists who conducted the duck genitalia and shrimp treadmill studies followed these two strategies to defend their work against attacks. The author of the duck study emphasized the importance of funding basic research (Brennan 2013), while the author of the shrimp study emphasized the links between the health of marine organisms and the safety of the seafood that humans consume (Scholnick 2014). While the first defense appeals to the value of the overall practice of funding basic research, the second is a direct defense of particular projects.[9]

However, both of these arguments have limited reach. Appealing to the benefits of the overall system may shield individual projects from demands for justification, but the system as a whole

chosen only in societies where people could expect to find themselves in the majority at least half the time (Barry 1991; Miller 2004).

[8]See n. 6 above, especially Dworkin (1985).

[9]See Rawls (1955) for a discussion of the distinction between justifying a practice and justifying a particular action falling under it, and the significance of the distinction for utilitarianism.

must still be justified, and opponents may well reject its value. Moreover, promoting the gains of the overall system cannot always remove individual projects from scrutiny. If an area of research is especially expensive and particularly removed from the benefits that citizens want, citizens or their representatives can rightly object that funding such research goes beyond what they believe is justified by appealing to the overall system of funding basic research, and that special justification must be provided for doing so because of the heavy tax burden. In the end, appeals to the benefits may prove unpersuasive to critics, and the government may decide to withdraw funding from a specific project, as in the highly publicized case of the Superconducting Supercollider project in the 1990s (Kevles 1995[1978]).

I have called the inability of non-perfectionist arguments to withstand the charge of wastefulness a limitation, but it counts as such only from the perspective of someone trying to defend science funding against attacks. This limitation need not be a bad thing from a democratic perspective; it might simply point to the right place to draw the line between scientific autonomy and political interference when funding costly scientific projects with taxpayer money. In any case, my goal here is not to decide which scientific projects are worth their cost, but to sketch the form that normative arguments for and against funding might take within a framework of private conceptions of the good. Ultimately, an institution justified on the basis of its benefits to citizens must be supported by evidence of such benefits or their likelihood, whether benefit is interpreted on a case-to-case basis or at a systemic level. If we endorse the liberal view that people should not be forced to pay for benefits they do not want, then the question of whether public funds should be spent on science will depend on the ability of defenders to persuade opponents of the value of funding it.

A Political Argument for Funding Science with Taxpayer Money

The Rawlsian argument puts science squarely in the category of opera, museums, zoos and lacrosse fields: goods that are justified by privately held conceptions of the good. There might be very good reasons to value them, but according to this argument large costs should not be forced on people who do not want the benefit. But does science properly belong in this category? There are clear parallels between the attacks against art and science on the basis of triviality and wasting money, and the defenses against these attacks appear to leave science and art in a similar position. But science has been the target of another line of attack mentioned earlier: that certain lines of scientific research are harmful to individual or national interests. Recent attacks on funding climate change research, for instance, have pursued this line of argument. This charge stems from the unique claim that science and scientists provide truths about the world. Scientific findings have the power to define which beliefs are reasonable to hold, and which public policies are reasonable to pursue. This creates significant political stakes around the outcomes of certain areas of research.

Appeals to private benefits or private value cannot account for these political implications. The problem is not that the private benefits framework gives the 'wrong' answer; there may well be no persuasive normative arguments for continued public funding when a majority does not wish to spend its money on research that it regards as harmful or biased. The problem is rather that conceptualizing funding for science as a matter of benefits for individuals overlooks the irreversible collective impact of scientific findings. The close connection between scientific inquiry and truth, and the special link between science and policy in the modern state, create additional reasons for publicly funding science that go beyond those that apply to the public provision of roads, bridges, infrastructure and even art. Recognizing the political consequences of scientific research is crucial not only for a more robust defense of continued public funding, but also for an appreciation of what role, if any, political interventions should play in decisions about allocating the public funds set aside for science.

Before I develop this argument, two clarifications are in order. First, I take it to be a sociological fact that science occupies the role of an authoritative source of truth in secular modern states. Even those who reject specific scientific claims do so on the grounds that they are wrong or unscientific, instead of denying that science provides authoritative and useful knowledge. I recognize that this need not be the case. The political status of science does not simply follow from its claim to reveal the truth (or the truth of this claim), but rather from the fact that this is widely accepted. Astrology also claims to reveal the truth, but has no policy influence (I hope!), and it is conceivable that scientists might be allowed to pursue their research in a theocratic society without being regarded as a reliable source of truth for policy purposes.

Secondly, I accept the liberal view that the state should not impose costs on people for public goods that are justified by appeals to privately held conceptions of the good that are neither shared nor determined through democratic procedures. This rules out a justification of public funding for science that focuses on its essential role in a certain vision of human flourishing and excellence – one that might appeal to the importance of the pursuit of truth for the proper development of human capacities or for the possibility of leading deeper and more complex lives. Instead, I will make the case based on a set of fundamental political interests that are shared by all who participate in a democratic society. The argument remains within a liberal framework, but provides a fuller account of how the role of funding for science should be theorized within it. In particular, I challenge Rawls's categorization of science funding as a discretionary good, the justification of which appeals purely to private benefits or private value.[10]

I now turn to the question of how the connection between science, truth and politics affects arguments for public funding. I will focus on three distinctly political roles for science: as a means of developing effective policies, as a resource for the democratic empowerment of citizens and as an agenda setter for political debates.

Most modern states depend on scientific expertise. Scientific knowledge enables policy makers to find effective means of realizing democratically determined ends. In areas ranging from human health to environmental protection, and from technological risk to foreign policy, science is instrumental to formulating good policies. It is a core assumption of modern states that claims to truth in policy contexts must be scientific. Since politicians and government officials cannot produce the knowledge they need, they depend on the existence of a scientific community capable of producing and sharing it. This establishes an intimate relationship between the activities of scientists at research institutions and the fundamental political interest in bringing about good outcomes and attaining collectively determined ends.[11] John Dewey recognized this relationship when he noted that 'genuine public policy cannot be generated unless it be informed by knowledge, and this knowledge does not exist except when there is systematic, thorough and well-equipped search and record' (Dewey 1927, 178).

This reason for funding science is instrumental; it stems from a shared public interest in good outcomes. Most political issues cannot be addressed only by appealing to values or conceptions of the good. On questions such as whether human activities contribute to climate change, whether smoking causes cancer or whether vaccines cause autism, citizens and their representatives depend on scientists to provide the facts – and the facts matter crucially. There is

[10]One way to situate my argument within a Rawlsian framework would be to say that science should fall within the domain of public reason – of fundamental questions about constitutional essentials and basic justice – rather than of discretionary goods. Yet the political role of science is not about justice *per se*, but rather about the requirements of a well-functioning democratic process. Perhaps Rawls's bipartite classification scheme of justice vs. non-justice goods is too restrictive for this purpose. Introducing a third category of goods that can be justified by appealing to political values more broadly might be a useful amendment.

[11]It is more common to link social science research to the achievement of desired policy outcomes, although I bracket this issue in this article. Desmond King shows how Britain's social science funding regime was built on the assumption of the identity of publicly funded research with political ends (King 1997). By contrast, the US National Science Foundation tends to favor social science research that looks more like basic science (Larsen 1992).

nothing specifically democratic about this role that science plays in politics; a totalitarian regime could likewise justify large amounts of public investment in scientific research on the grounds that it would improve outcomes.

Democracies have a further political interest in funding scientific research, which is not shared with non-democracies: scientific inquiry can provide citizens with a source of knowledge that is independent from the state, which citizens can use to hold government officials accountable. At the very least, democratic accountability requires a sphere of free public discourse. However, on complex technical issues, common sense knowledge is unlikely to be sufficient to give citizens a meaningful ability to check the activities of government officials, since decisions are often justified by appeals to expert knowledge. Citizens must also have access to expertise to be able to understand and challenge policy makers. Scientific inquiry can fulfill this need and support a specifically democratic form of competence and empowerment for citizens. Publicly available scientific knowledge can also allow citizens to revise their opinions, form more informed preferences and reconsider their ends. These are related to good outcomes, but they have greater normative weight because of their relationship to the essential condition of democratic legitimacy: that citizens have a meaningful opportunity to hold policy makers accountable.

The two arguments provided so far focus on the role of scientific knowledge in making and judging political decisions. However, scientific inquiry also plays an important role in determining which issues will make it to the decision stage in the first place. Scientists' decisions about which questions to pursue determine which issues will acquire political salience, and the way scientists choose to frame a question shapes how the public and politicians will think about it. On issues such as healthcare, aging, climate change and environmental quality, scientific findings have set the political agenda and defined the terms of public debate (Sarewitz 2010). For instance, scientists studying climate change early on prioritized understanding the causal mechanisms and predicting the consequences, based on the assumption that solutions would follow more readily from an understanding of the underlying physical processes (Sarewitz 2010). Funding for research on the possibilities for adaptation and technological innovation therefore lagged behind funding for studies of the physical science for many years. This, in turn, limited the options available for tackling the problem, even while placing the fact of climate change and its impacts irreversibly on the political agenda.

As E.E. Schattschneider famously put it, 'The definition of alternatives is the supreme instrument of power' (Schattschneider 1960, 68). Those who make the funding decisions can intentionally or unintentionally rule out certain courses of action. This makes funding decisions for science the locus of an important political power. Science can enhance democratic rule if the knowledge that becomes available supports democratic priorities and increases a society's ability to shape its future through favored courses of action. But it can also constrain democratic possibilities if new knowledge thwarts collectively determined goals and aspirations or creates unforeseen – and potentially unwanted – needs and problems. Whether the relationship between science and democracy will be a productive one therefore depends not only on the quality and reliability of the knowledge, but also on decisions about what types of knowledge are pursued.

We are now in a position to consider what these three arguments – for allowing effective policies, democratic accountability and agenda setting – imply for funding decisions. I contrast the implications of this view with Bush's recommendation to give scientists a high degree of autonomy to attain the greatest material benefits for the public.

The political impact of scientific knowledge, and especially its role in bringing about certain outcomes, may place some areas of science funding in the category of goods whose public provision is required by justice. For instance, if there is a duty of justice to help those who are harmed by the natural disasters caused by climate change, funding climate research may be necessary for the ability of the state to fulfill this duty. Similarly, if the state has a duty to provide healthcare for those with certain rare diseases, this might require funding research into the discovery of cures. The argument follows something like a transitivity principle for duty:

if you have a duty to do x, you also have the duty to do those things that are a means to x.[12] In practice, it will often be highly unclear whether a particular area of research will yield the right kind of information to fulfill a duty of justice. It will be uncertain whether funded projects will succeed, whether they will succeed in time, whether the findings will turn out to help the cause of justice rather than create new and unimagined injustices, and so on. But in cases where certain avenues of research can plausibly be tied to research necessary to realize duties of justice, there will also be a duty to publicly support these areas of inquiry.

The political role of science also has implications for how decisions about the distribution of funds should be made. If the political benefits of science form at least part of the justification for public support of science, then institutions that make funding decisions should be designed in a way that helps realize the desired political benefits. Which decision structures will best realize these goals is ultimately an empirical question, but in the absence of the right sort of data and given the difficulty of testing alternative institutional structures, we need to rely on theoretical principles to guide the process of institutional design. The agenda-setting power of science and its effect on democratic rule suggests that priority-setting decisions should involve some democratic input. Decisions about how funds should be distributed between biomedical research and environmental studies, space exploration and oceanography should be made by appealing to citizens' values and preferences. These decisions are analogous to fundamentally political questions about how to distribute funds between education and healthcare, national defense and environmental quality. Since science is supported by public funds for the purpose of public benefit, however that is to be defined, the priorities of the scientific research agenda should be set with democratic input. Expert opinions on the likelihood of making significant progress in these scientific areas will be relevant to the decision, of course, but in the end, the priorities must be ordered democratically. Indeed, the current practice in the United States is to shape priorities for science funding on the basis of national political priorities.

Since the beginning of the twenty-first century, there has been a significant increase in the share of scientific research funded by corporations, philanthropists and private foundations (Broad 2014; Greenberg 2007). While this might speed up the progress of science and increase its public benefits, it also raises the worry that the interests, needs and priorities of corporations and private individuals will shape the scientific agenda. This may mean that private organizations can circumvent political processes by enacting their vision of a good society through their private funding decisions, rather than by seeking majority support. The increase in privately funded scientific research therefore also has implications for the distribution of public funding. The distributive impact of scientific projects becomes particularly salient as more science becomes privately funded. If scientific issues that benefit certain groups or industries are supported disproportionately through private funds, then it might be necessary to counterbalance the effects of private science through more directed public funding.

It is common to draw the line for political input into science funding at the general level of priority setting, leaving the distribution of funds within each area to scientists. This is inadequate because it leaves the determination of how a particular issue will be considered in the public sphere and the alternatives that will be available to decision makers entirely to scientists. Formal decision-making power may still lie in political processes, but it is constrained by funding decisions made far earlier by scientists. The distribution of funds within an area has different political implications than priority setting at a more general level. While the latter determines which problems will gain more traction, the former determines the range of possible answers to a particular problem. At the decision stage, laypeople can either accept one of the available scientific options, or they can reject them all, but they cannot produce new science. This is the limitation of studying the relationship between science and politics by focusing only on the

[12]As Robert Goodin (2012) puts it, 'You ought to do things that are means towards the principal thing for the same reason you ought to do that principal thing.'

decision stage. The success of democratic deliberation about how to act depends on the availability of a range of competing alternative views that citizens and representatives can examine and challenge.

The agenda-setting role of science points to the need for more democratic input into funding decisions. The next question is what the other two arguments – from the interest in better outcomes and in empowering citizens to hold their government accountable – imply about the desirability of political intervention in funding allocation decisions. One plausible answer is that both provide prima facie reasons to insulate funding decisions from outside interference. The success of the relationship between scientific inquiry and competent policy making depends on the scientific community's ability to set internal standards of quality. The distribution of funding among competing research proposals is one of the main ways in which the scientific community discriminates good ideas from bad ones. The overall success of this gatekeeping mechanism in producing reliable knowledge justifies policy makers' reliance on the findings of scientists. As long as it is accepted that scientists are more capable of judging the quality of proposals, democracies have an interest in protecting scientific funding from outside attempts to guide its direction. Political interference in funding decisions can also be problematic because it can impose myopic preferences over long-term commitments. Politicians operate on a short time horizon, which may lead them to give up support for particular areas of research prematurely, before they yield results. Worse, political interference may be directly motivated by a desire to prevent good policies by blocking the emergence of truth. This also effectively prevents citizens from acquiring the information they need to criticize government policies. When a government decides to withdraw funds from research on a pressing political issue such as climate change, it is reasonable to suspect that the interference is motivated by a desire to suppress politically inconvenient truths and thereby prevent sensible policy making on the issue.

These arguments support a prima facie case for scientific autonomy over the distribution of public funds. The case is only prima facie because the use of funding as a gatekeeping mechanism for quality also provides a reason to limit scientific autonomy over the distribution of funds. Recall the earlier discussion of Kuhn's claim that scientists left to pursue their own puzzles without interference would prepare the necessary conditions for the most radical discoveries, even as they actively resisted new ideas that challenge the assumptions of their paradigm. I pointed out that under a system in which most scientific research depends on large amounts of funding, those who control funding decisions might succeed only too well in rejecting radical new ideas that would lead to the most significant discoveries. If scientists working within a paradigm also have control over the distribution of funds, then the easiest way to ensure the continued success of the paradigm is by denying funding to projects that challenge it.[13]

The role that funding has come to play in scientific research means that the possibility of dissent in science depends not only on the absence of constraints on free inquiry, but also on an active funding strategy that supports dissenting views and distributes funds among scientists pursuing a wide variety of approaches. Leaving the decision entirely to scientists' assessment of quality in light of existing standards can prevent the funding of new ideas that can potentially challenge those very standards and expose the errors of widely accepted scientific views. Polanyi compared scientists to actors in a market economy, whose uncoordinated pursuit of truth would bring about the best results for all. To extend his analogy, giving scientific agencies full control over the distribution of funds could lead to the emergence of monopolies in knowledge production, led by the assumptions and priorities of those who sit on funding committees. It is therefore necessary to establish funding institutions that can fulfill the function of antitrust law for science and ensure fair competition among scientific ideas.

The political impact of scientific research creates a democratic stake in the existence of diverse viewpoints within the scientific community, that are capable of challenging the reigning

[13]For evidence that this is happening, see Nicholson and Ioannidis (2012).

paradigms. This might be realized through institutional innovations such as earmarking funds for unconventional approaches and less established scientists, ensuring a diversity of scientific viewpoints on funding committees, reserving seats for non-experts and experts from different scientific disciplines, supporting more speculative and risky long-term research, and distributing some portion of funds through a lottery among a number of projects that meet a certain threshold of quality.[14] It should not be surprising that these kinds of changes would be good for science as well as for democracy; the point is that the political justification for publicly funding research places some of the responsibility for setting up and overseeing such institutions on policy makers and citizens, rather than giving the scientific community full autonomy over the use of public funds. This is not an argument for leaving particular funding decisions to citizens or bureaucrats, but for democratic responsibility and oversight for the creation and maintenance of a funding system that encourages competition, diversity and dissent within the scientific community.

Conclusion

In order to respond to attacks against the level and distribution of public funds for science, we first need to understand how science funding has been justified and then consider whether these justifications are satisfactory. Different arguments for supporting science with public funds suggest different answers regarding the acceptability of reducing funding or interfering politically with how it is distributed. To answer these questions, I first examined Bush's arguments for setting up a vast federally funded scientific enterprise after the war on the grounds that it would boost economic progress and productivity. I then turned to Rawls's more modest liberal argument for funding science as a voluntary good, which could be provided by the state if individuals found the benefits desirable based on their private conceptions of the good. The problem with both of these views, I argued, is that they neglected the political consequences of funding science. Neither can help us understand what is truly at stake, for example, with the view that if climate change research appears to harm American economic interests, there should simply be less funding for it.

To account for the political stakes in funding science, I sketched an alternative justification for funding science, rooted in the shared democratic interests of citizens: in bringing about good policy outcomes, setting the political agenda, and acquiring the knowledge and competence to hold policy makers accountable on technical issues. These three interests pull in different directions in the context of the desirability of political input into funding decisions. The agenda-setting power of science points to the necessity of more democratic input, both in setting priorities and in diversifying approaches within issue areas, especially under a regime with more privately funded science. The need for reliable knowledge for policy making and accountability points in the direction of giving autonomy to scientists, but must be balanced against the worry that a closed expert community might develop patterns of funding that stifle dissent and innovation, which in turn would limit the opportunities for contestation in the public sphere.

The question of how to set up funding institutions that encourage dissent and facilitate the emergence of significant discoveries is usually thought to be a concern for scientists and philosophers of science. One of my goals here was to show that this problem is also a democratic one, and the responsibility for resolving it must be shared between policy makers and scientists. This is not only because scientific research is pursued with public funds and invariably justified by appealing to public benefits, but also because the direction of new scientific research, the reliability of scientific findings and the possibility of dissent within the scientific community have a direct impact on democratic deliberation and decision making. Public funding for science is

[14]For more on funding science through a lottery, see Avin (in press).

therefore a deeply political issue, from the justification of the decision to support science with public funds to making specific decisions about how to distribute funds – and rightly so.

Acknowledgements. I am very grateful to Eric Beerbohm, Paul Bou-Habib, Michael Frazer, Nancy Rosenblum, Dennis Thompson and Richard Tuck for detailed comments. Earlier versions of this article were presented at the Institute of Historical Research, Oxford Centre for the Study of Social Justice, and University of East Anglia. I thank the audiences for their helpful feedback. I also thank the Edmond J. Safra Center for the generous fellowship that allowed me to focus on writing this article.

References

Avin S (in press) Centralized funding and epistemic exploration. *The British Journal for the Philosophy of Science*. doi:10.1093/bjps/axx059

Barry B (1991) Is democracy special? In Barry B (ed.), *Democracy and Power: Essays in Political Theory Part 1*. Oxford: Clarendon Press, pp. 24–60.

Barry B (1995) *Justice as Impartiality: A Treatise on Social Justice*, Vol. 2. Oxford: Oxford University Press.

Brennan P (2013). Why I study duck genitalia. Available at http://www.slate.com/articles/health_and_science/science/2013/04/duck_penis_controversy_nsf_is_right_to_fund_basic_research_that_conservatives.html, accessed 14 August 2018.

Brighouse H (1995) Neutrality, publicity, and state funding of the arts. *Philosophy & Public Affairs* **24** (1), 35–63.

Broad W (2014) Billionaires with big ideas are privatizing science. *The New York Times*, 15 March. Available at http://www.nytimes.com/2014/03/16/science/billionaires-with-big-ideas-are-privatizing-american-science.html?_r=0, accessed 14 August 2018.

Bush V (1960 [1945]) *Science: The Endless Frontier*. Washington, DC: National Science Foundation.

Carroll N (1987) Can government funding of the arts be justified theoretically? *Journal of Aesthetic Education* **21** (1), 21–35.

Collini S (2012) *What Are Universities For?* London: Penguin Books.

Dewey J (1927) *The Public and its Problems*. Chicago, IL: The Swallow Press.

Douglas H (2009) *Science, Policy, and the Value-Free Ideal*. Pittsburgh, PA: The University of Pittsburgh Press.

Dupré J (2004) Science and values and values in science. *Inquiry*, **47**, 505–514.

Dworkin R (1985) *A Matter of Principle*. Cambridge, MA: Harvard University Press.

Feinberg J (1994) Not with my tax money: the problem of justifying government subsidies for the arts. *Public Affairs Quarterly* **8** (2), 101–123.

Fox News (2011) Your tax dollars at work: shrimp on treadmills, 26 May. Available at http://www.video.foxnews.com/v/960953334001/?#sp=show-clips, accessed 14 August 2018.

Fox News (2013) Was duck penis study an appropriate use of taxpayer money? 25 March. Available at http://www.foxnews.com/opinion/2013/03/25/was-duck-penis-study-appropriate-use-taxpayer-money.html, accessed 14 August 2018.

Goodin R (2012) Excused by the unwillingness of others? *Analysis*, **72** (1), 18–24.

Greenberg D (2007) *Science for Sale*. Chicago, IL: University of Chicago Press.

Greenfieldboyce N (2011) 'Shrimp on a treadmill': the politics of 'silly' studies. Available at https://www.npr.org/2011/08/23/139852035/shrimp-on-a-treadmill-the-politics-of-silly-studies, accessed 14 August 2018.

Hayek FA (1945) The use of knowledge in society. *The American Economic Review* **35** (4), 519–530.

Kevles DJ (1995 [1978]) *The Physicists: The History of a Scientific Community in Modern America*. Cambridge, MA: Harvard University Press.

King D (1997) Creating a funding regime for social research in Britain: the Heyworth Committee on Social Studies and the founding of the Social Science Research Council. *Minerva* **35**, 1–26.

Kitcher P (2001) *Science, Truth, and Democracy*. Oxford: Oxford University Press.

Kleinman DL (1995) *Politics on the Endless Frontier: Postwar Research Policy in the United States*. Durham, NC: Duke University Press.

Kuhn TS (1962) *The Structure of Scientific Revolutions*. Chicago, IL: University of Chicago Press.

Larsen ON (1992) *Milestones and Millstones: Social Science at the National Science Foundation, 1945-1991*. New Brunswick, NJ: Transaction Publishers.

Mann AK (2000) *For Better or For Worse: The Marriage of Science and Government in the United States*. New York: Columbia University Press.

Miller D (2004) Justice, democracy and public goods. In Dowding K, Goodin R and Pateman C (eds), *Justice and Democracy: Essays for Brian Barry*. Cambridge: Cambridge University Press, pp. 127–149.

Munoz-Dardé V (2013) In the face of austerity: the puzzle of museums and universities. *Journal of Political Philosophy* **21** (2), 221–242.

Nicholson JM and Ioannidis JP (2012) Research grants: conform and be funded. *Nature* **492** (7427), 34.

Nozick R (1974) *Anarchy, State, and Utopia*. New York: Harper and Row.

Nussbaum M (2016) *Not for Profit: Why Democracy Needs the Humanities*. Princeton, NJ: Public Square.
Polanyi M (1941a) The growth of thought in society. *Economica* **8** (32), 428–456.
Polanyi M (1941b) Cultural significance of science. *Nature* **147** (3717), 119.
Polanyi M (1945a) The autonomy of science. *The Scientific Monthly* **60** (2), 141–150.
Polanyi M (1945b) The planning of science. *The Political Quarterly* **16** (4), 316–328.
Polanyi M (1951) *The Logic of Liberty: Reflections and Rejoinders*. Chicago, IL: University of Chicago Press.
Polanyi M (1962) The republic of science: its political and economic theory. *Minerva* **1** (1), 54–73.
Rawls J (1955) Two concepts of rules. *The Philosophical Review* **64** (1), 3–32.
Rawls J (1971) *A Theory of Justice*. Cambridge, MA: Belknap Press of Harvard University Press.
Rawls J (1996) *Political Liberalism*. New York: Columbia University Press.
Rawls J (2001) *Justice as Fairness: A Restatement*. Cambridge, MA: Harvard University Press.
Rice D and King L (2017) Trump's budget proposal 'savages' climate research, scientists say. *USA Today*, 23 May. Available at https://www.usatoday.com/story/news/nation/2017/05/23/trumps-budget-proposal-savages-climate-research-scientists-say/102062556/, accessed 14 August 2018.
Sarewitz D (2010) Normal science and limits on knowledge: what we seek to know, what we choose not to know, what we don't bother knowing. *Social Research* **77** (3), 997–1010.
Savage JD (1999) *Funding Science in America: Congress, Universities, and the Politics of the Academic Pork Barrel*. Cambridge: Cambridge University Press.
Schattschneider EE (1960) *The Semi-Sovereign People: A Realist's View of Democracy in America*. New York: Holt, Rinehalt and Winston.
Scholnick D (2014) How a $47 shrimp treadmill became a $3-million political plaything. Available at https://www.chronicle.com/blogs/conversation/2014/11/13/how-a-47-shrimp-treadmill-became-a-3-million-political-plaything, accessed 14 August 2018.
Tuck R (2008) *Free Riding*. Cambridge, MA: Harvard University Press.
Waldman S (2017) Trump administration seeks big budget cuts for climate research. Available at https://www.scientificamerican.com/article/trump-administration-seeks-big-budget-cuts-for-climate-research, accessed 14 August 2018.
Wicksell K (1958) A new principle of just taxation. In Musgrave R and Peacock A (eds), *Classics in the Theory of Public Finance*. London: Palgrave Macmillan, pp. 72–118.

Cite this article: Pamuk Z (2018). Justifying Public Funding for Science. *British Journal of Political Science* 49(1), 1–16. https://doi.org/10.1017/S0007123418000431