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Arguments against efficiency in science

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Abstract
A recent commentary critiqued the embrace of performance metrics at research universities. Drawing on our research studying the metascience movement, we suggest that the drive to maximize efficiency in science is increasingly extending beyond performance metrics, into labs themselves. Because institutional and public audiences are predisposed to viewing science in simple terms, it can be challenging for scientists to articulate counterarguments to policies that increase transparency and accountability in the name of efficiency. This short piece offers a sketch of an argument against treating efficiency as the lodestar for science.

Keywords
efficiency, metascience, performance metrics, replication crisis, science policy

Résumé
Un article récent critiquait l'adoption dans les universités de recherche des indicateurs de performance. A partir de notre étude portant sur le mouvement de la méta-science, nous suggérons que la volonté de maximiser l'efficacité de la science s'étend de plus en plus, au-delà des indicateurs de performance, au sein même des laboratoires. Puisque les institutions et le public en général sont prédisposés à appréhender les sciences à l'aide de termes simples, il peut être difficile pour les scientifiques d'articuler des arguments contre les politiques visant à accroître la transparence et la responsabilité au nom de l'efficacité. Ce court papier ébauche un raisonnement qui va à l'encontre d'une démarche selon laquelle l'efficacité devrait être la boussole de la recherche scientifique.

Mots-clés
crise de la reproductibilité, efficacité, indicateurs de performance, méta-science, politique scientifique

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In this journal, a recent commentary urges us to 'stop evaluating science' (Hallonsten, 2021). In it, Olof Hallonsten argues that universities have adopted performance metrics to increase research efficiency to maximize the economic benefits the university produces. The problem, according to the piece, is that quantitative metrics inevitability rely on misleading indicators of quality like citation counts. These problems compound as scientists begin to orient themselves toward these artificial metrics rather than the traditional evaluative mechanism, qualitative appraisals from their peer scientists.

For the last three years, we have been studying metascience, a movement born in reaction to the supposed replication crisis in science (Peterson and Panofsky, 2020). In some ways, metascience and the drive for performance metrics are quite different. The latter focuses on the *products* of science and is motivated by the promise of *economic growth*. In contrast, metascience is focused on the *practice* of science and uses *economic models* to conceptualize how science operates and how it can be improved.

Yet, the economism at the heart of both projects leads them to adopt efficiency as their primary goal. For instance, a recent manifesto praises metascience for generating 'substantial empirical evidence for the existence and prevalence of threats to efficiency in knowledge accumulation' (Munafò et al., 2017: 1). Further, both seek to improve efficiency through the manipulation of existing incentives. As another manifesto proclaims, 'The most ambitious and durable transformations will likely require considerable realignment of the reward and incentive system in science' (Ioannidis et al., 2015: 5). Specifically, metascientists are seeking to make science more efficient by incentivizing scientists to change their practices in a number of domains, from posting data and materials more openly to engaging in more replication work.

The arguments of the proponents of evaluations and metascientific reform are firmly rooted in the values of liberal society: transparency, accountability, and productivity. Counterarguments are easily cast as defensiveness or obscurantism. This is not just an academic problem. Scientists we interviewed told us that they felt constrained expressing their skepticism of reforms because, while reformers can draw on popular rhetoric of how science should operate, critics must wade into the murky waters of real scientific practice.

Late in his piece, Hallonsten addresses the challenge of changing the minds of those 'champions of the view that science is insufficiently productive' (2021: 20). He notes that advocates:

> will demand evidence that they can comprehend and, preferably, compare with their own simple and straightforward numbers. A list of counter-examples will therefore probably not suffice, since it can be discarded as mere 'anecdotal evidence' against which also the shallowest and most oversimplified statistics usually win. The argument should therefore center on the basis of the supposition itself [. . .]. (2021: 20)

What follows is a sketch of an argument against efficiency in science that we hope prompts further conversation. Ultimately, our goal is not to suggest that the concept of efficiency has no place in science but, rather, that efficiency is only one value in a cluster of values that includes utility, significance, elegance and, even, sustainability and justice. That efficiency is the easiest to articulate because it accords with other

dominant bureaucratic and economic values should not allow it to win policy discussions by default. The fact that the argument *against* efficiency is challenging makes it all the more pressing to make it.

We cannot equate efficiency with progress because we do not know what progress is

Among classical philosophers of science, the unpredictability of scientific development was taken as a maxim. For instance, Michael Polanyi (1962: 10) asserts: 'You can kill or mutilate the advance of science, you cannot shape it. For it can advance only by essentially unpredictable steps, pursuing problems of its own, and the practical benefits of these advances will be incidental and hence doubly unpredictable.' Similarly, Karl Popper argues: 'We cannot predict, by rational or scientific methods, the future growth of our scientific knowledge' (1957: vi–vii).

Our inability to chart basic scientific progress undermines the ability to measure efficiency. The notion of efficiency only makes sense in the context of established means/ends relationships. The goal is to organize the means in the optimal way to achieve the desired end. The problem is that, in the area of basic science, the end is unknown.

How are we to recognize progress? Scholars have offered 'manipulationist' accounts focusing on the development of interventional technologies (Woodward, 2005). Others have focused on the cognitive, conceptual, and explanatory evolution of theories (Kitcher, 1995). Science studies scholars have conceptualized progress as a process in which scientists enroll other scientists and outsiders into their projects (Callon, 1986; Latour, 1987) or use boundary objects to extend the reach of their research programs (Star and Griesemer, 1989). This riot of opinions is not contained to those who study scientists. There is little agreement among the scientists themselves about what constitutes a significant contribution. There is reason to believe this dissensus is not a mere technical deficiency, but is a constitutive feature of the cutting edge of science (Cole, 1992: 18). Rather than clarity, these accounts underscore the complexity of conceptualizing progress in science.

Metascientific activists have framed gains in efficiency in terms of improving the proportion of replicable claims to nonreplicable claims in the literature (e.g., Ioannidis, 2012). Yet, scientists we interviewed disagreed that this was a good strategy. A National Institutes of Health researcher told us: 'I think it makes it less efficient. And, then, if we're spending money on reproducing things, where the money can be spent on discovering things, that's obviously an inefficiency.' This was furthered by a biologist at MIT who contrasted these organized replication efforts with what he viewed as the current 'Darwinian process [. . .] which progressively sifts out the findings which are not replicable and not extended by others'.

Under this alternative theory of scientific efficiency, there is a natural process in which researchers produce many claims. Some may be flat wrong. Some may be right, yet hard to reproduce, or only narrowly correct and, therefore, be of limited use. However, some provide robust and exciting grounds to build upon and these become the shoulders on which future generations stand (Peterson and Panofsky, 2021). Reallocating resources to perform a rear-guard action of ensuring reproducibility reduces the funding that goes to producing new science.

Incentivizing efficiency can be self-defeating

A reader may agree that efforts to erect programs to increase efficiency in science are not built on granite foundations, yet still believe that efforts to elicit generally desirable behavior through the manipulation of incentives is a worthy project. The fact that such an impulse aligns with traditional liberal values like universalism and accountability (e.g., Thorpe, 2008) makes it seem like an admirable ambition, even if ultimately unattainable.

Yet, scientific cultures are not Lego sets that can be taken apart and reconstructed to meet one's ideals. They have organically evolved their own systems of communication and evaluation. They interpret broadly accepted, but abstract, values like skepticism, verification, and transparency in ways sensible to their particular contexts. Applying blanket rules to maximize efficiency in such systems can lead to unintended and, even, counterproductive outcomes.

Reformers in science have adopted economic language and, in so doing, have treated scientists as actors primarily motivated by material rewards (e.g., Harris, 2017; Nosek et al., 2012). This can be compared to a Mertonian account in which scientists are motivated by the interlocking system of scientific norms. Under an economic account, the best way to change behavior in science is to alter the incentive structure to reward or punish specific behaviors. Rational scientists will then react to those incentives and outcomes can be ensured.

The problem with incentive-based legislation has been detailed in a recent book by economist Samuel Bowles (2016). He argues that trying to engineer social systems by treating actors as thoroughly self-interested and incentive-driven ignores the useful role that preexisting cultural values play. In the reformer's mind, newly introduced incentives and existing preferences are 'additively separable' from existing values. That is, if actors already value a behavior, then adding an incentive can only have a positive, cumulative effect. Yet, this need not be the case. Bowles details laboratory and field studies that show how the introduction of incentives can reduce or even reverse existing values.

Bowles suggests that attempting to remove inefficiencies in a market may, ironically, produce worse outcomes as existing norms and values, which can help balance out market distortions, get replaced with explicit rules backed by specific rewards and punishments. The problem is that using incentives to encourage specific behaviors can 'crowd out' existing preferences by changing how people interpret their environments.

This is especially risky when these manipulations are imposed by external groups. When we asked if the movement toward greater transparency in research was being initiated by the scientists themselves, the leader of an international consortia of data repositories explained: 'To me, it seems more like it's being driven by top down policies, government policies, because the governments and the funders, they have a better sense of how important this is.' Yet, this paternalism is abrasive to scientists who have thrived with autonomy and helps explain this reaction by a physicist to the new mandates: 'Now everybody has to download all his data files to these repositories or whatever these things are called [. . .]. No one will ever look at them. And all these data we download? It takes time and it takes resources.' The data sharing that had been part of professional courtesy had been transformed into a blanket policy, robbing it of its meaning. Resistance to reform initiatives by scientists may inspire greater top-down pressure and additional rules which will engender greater resistance.

Bowles concludes that reformers face a 'legislator's dilemma' because efficiency, value diversity, and voluntary participation stand in insurmountable tension. Increasing efficiency through mandatory data deposition is an example where the policy aim, admirable in the abstract, can only become enacted through increased bureaucratic control which reduces the autonomy of the scientific community. In this, and in many other cases, the relatively inefficient practices that have evolved organically within scientific communities might, on balance, be preferable.

Conclusion

Science is constantly forming and reforming. Yet, activists within science seek to bring these processes under human observation and control to make them more accountable and efficient. However, too often reformers lack practical knowledge about the domain in which they tinker and, as Michael Oakeshott said about the political reformer, are 'bewildered by a tradition and a habit of behavior of which [they know] only the surface' (1991: 36).

Our purpose for writing this is not to argue that we should all be against efficiency in science. Rather, it is to offer the beginnings of a counterargument, so that any reform dressed in the language of efficiency must address what it means by efficiency and how it might impinge on other values. Science reform should be a slow, reversable process with input from funders, institutions, those who study science, and, most importantly, the scientists themselves. Defensiveness and obfuscation are enemies of science, yet resistance to reforms may have reasonable roots.

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