Open Science and Reproducibility of Science:
Why Openness Is Not Just an Option - It Is an Obligation

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1. Introduction

One question to consider a little before venturing into theory is whether science is really the most certain way of understanding the world that man has ever had. Why is it that so much of it becomes wrong, unrepeatable, or indeed unavailable to those who need to know it the most? It is not flourishing, but one of the most pressing practical issues in modern research. The so-called replication crisis, which has attracted much attention in the social and biomedical sciences over the last ten years, has highlighted a structural weakness in how science is practiced, published, and believed. And the core of the suggested solutions is the notion of Open Science.

Open Science is, in its simplest form, a campaign that promotes the free and open access to scientific information, techniques and findings. It encompasses open access publication, open data, open-source software, pre-registration of studies and collaborative research practices. Open Science is a product of and a requirement for reproducibility, i.e., achieving the same results using the same data and methods. The two notions go hand in hand; reproducibility cannot be proven without openness, and openness has limited scientific merit without reproducibility.

This essay examines the practical meaning of Open Science, the reasons science has become characterized by a focus on reproducibility, how ethical standards and academic integrity paradigms collide with the issue, and what is truly under the gun, not just researchers but society in general. Based on the European Commission textbook on ethics in research (2010), the MIT Academic Integrity Handbook, and some critical approaches to the scientific practice, the essay will contend that adopting Open Science is not just a matter of choice of methodology, but rather a moral duty that scientists have towards knowledge, society, and future generations.

2. What Do We Mean by Open Science?

Although it is sometimes treated as a single concept, Open Science is better understood as a collection of related practices and values. At the most general level, it concerns eliminating barriers to paywalls, proprietary information, obscurantist practices, and non-transparent peer review that impede the free flow of scientific knowledge. Practically, it includes open access publishing (making research publicly accessible on the web), open data (making raw data publicly accessible so others can verify them, reanalyze them or build upon them), open methodology (documenting research procedures to the extent necessary to be replicated), and pre-registration (publicly committing to hypotheses and analysis plans in advance of data collection).

The open-access aspect, in itself, carries significant ethical implications. Researchers are not only obliged to the scientific community but also to the whole society, as the European Textbook on Ethics in Research (2010) by the European Commission notes, especially when public funds are used. In the case of research funded by taxpayers and locked behind prohibitive journal subscriptions, the clear inequity is evident: people pay to know what they cannot know. It is not a theoretical issue. In other areas, such as public health, development economics, or agricultural science, where work at the Faculty of Tropical Agrisciences directly applies, limited access to knowledge can affect policymakers, practitioners, and communities in low-income nations, who are potentially the most beneficiaries of scientific innovations.

It is necessary to note that there are no complications with Open Science. It is understandable that when raw data is shared, privacy and confidentiality are threatened, as well as the risk of misuse of sensitive information. Open peer review, despite its merits in principle, can subject reviewers and authors to social pressure that may lead to a lack of candour. When open-access requirements are uniform, they can unintentionally disadvantage researchers at resource-poor institutions, as they may not be able to pay article processing fees. It is about actual tensions, and an attentive approach to Open Science involves bearing them in mind rather than assuming they do not exist.

3. The Reproducibility Crisis: What Went Wrong?

The term replication crisis came into common use in scientific literature circa 20112015, following a wave of high-profile replication failures in fields such as psychology, medicine, and economics, prompting self-reflection among these fields. A 2015 project by the Open Science Collaboration that attempted to replicate 100 published psychology studies found that, on average, the effect sizes of the replications were about half those of the originals, and many were not statistically significant. The same has raised concerns across cancer biology, nutrition science, and even certain aspects of economics.

What went wrong? The causes are numerous and systemic. Publication bias, where journals are more likely to publish novel and positive results than null or replication results, can bias the published literature towards results that may not be representative of reality. Given the high pressure on researchers to generate high-impact results, they might, knowingly or unknowingly, be tempted to adopt practices that exaggerate apparent effect sizes: flexible stopping rules, reporting only successful results, failing to correct for multiple comparisons, or merely running the analysis until something works. They are a group of practices that, when combined, are sometimes referred to as questionable research practices, lying between honest error and outright fraud. Nevertheless, the net impact of this on the quality of the literature through its cumulative effect is harmful in any case.

Writing in Cadmus Journal, Ramirez and Cayon-Peña (2017) point out that this is one of the things that resonates in science: complete incompleteness. There is no single science that can be said to capture reality, and all scientific knowledge is tentative. The fact that science is fallible is not the problem; it's its strength, not its weakness. The issue here is that institutional incentive systems stimulate researchers to report uncertain results, with the sense that the evidence on which they are based is not valid, and that the conventions of a discipline make it hard or humiliating to recognize the limits, report negative results, or retract earlier judgments. Honesty, as defined by the MIT Academic Integrity Handbook (2012), is the cornerstone of good academic work. This is true of science as well.

Failure of reproducibility is not a statistical inconvenience. They are a violation of the epistemic contract that confers authority on science. When a trial result cannot be reproduced, patients may receive an ineffective or harmful treatment. If an economic model cannot be replicated, it can lead to poor policy decisions. When results in the field of nutrition science keep flipping, citizens lose faith in professional advice. It is much more than the laboratory, in other words, the stakes.

4. Open Science as the Ethical Response

Open Science and research ethics have not just an instrumental relationship; they are constitutive. Scientific practice entails ethical commitments of transparency, honesty and accountability, and Open Science operationalizes these in specific, verifiable terms.

Pre-registration is one of the most practically impactful tools of Open Science, which should be considered. Researchers publicly stating hypotheses, variables, and analysis plans before data collection make it much more difficult to engage in outcome-switching or post-hoc rationalization of exploratory analyses as confirmatory ones. Although pre-registration does not remove the researcher's discretion or creativity, it establishes a clear, auditable line between planned and discovered. This is fundamentally an act of epistemic honesty, a recognition that the difference between hypothesis-driven and data-driven inquiry is important for interpreting and weighing findings.

Open data serves a similar ethical purpose. As soon as datasets are publicly published, other scientists can verify computations, diagnose mistakes, and experiment with other methods of analysis. This is what good science needs to be subjected to. The MIT Academic Integrity Handbook (2012) emphasizes that citation and attribution are not merely bureaucratic requirements but rather principles that enable the scholarly community to trace the origins of ideas and assertions. The same applies to open data: unless the evidence supporting a statement is available, the statement cannot be assessed or even formulated.

In the European Textbook on Ethics in Research (European Commission, 2010), the principle of responsibility to society is the key to research ethics. Scientists do not work in a vacuum; they work in institutions, access state funding, and generate knowledge used in decision-making that affects millions of citizens. Here, the fact that data, methods, and results are kept proprietary is not merely an inefficiency; it is an attempt to violate the social contract that legitimizes the privileged epistemic position of science. Open Science is a scientific practice that aligns with an ethical requirement, holding researchers accountable not only to fellow scientists but also to the public at large.

An intergenerational aspect should also be considered. Science is cumulative: the present discoveries are the bricks of those that will come later. Should such findings be incorrect, unreadable or inaccessible, then that waste is not merely an economic one, but an epistemic one, because the foundations upon which further research is based are unsound. This is especially sharp in applied disciplines, where scientific knowledge is directly applicable in practice. A key methodological and ethical issue in tropical agriculture and development economics, e.g. in studies of the external validity of research results, i.e. whether the results can be replicated in a different situation. The practices of Open Science, such as data sharing and methodological transparency, enable researchers and practitioners to determine whether findings are travelling across contexts, rather than assuming they are.

5. Good Science, Bad Science, and the Norms That Distinguish Them

The theme of good and bad science has reoccurred in the literature used in this course. Good science, in general terms, is rigorous, transparent, truthful to its shortcomings and subject to revision in the face of new evidence. Bad science, in contrast, could comprise the selective reporting, exaggeration, sloppiness in its methodology, or, in its worst manifestations, outright fabrication and falsification.

However, what is not fully understood is how institutional and cultural factors can lead a researcher to engage in bad science even when they are not a bad researcher themselves. The culture of publish-or-perish in academia, in which career success is closely linked to generating high-impact publications, establishes incentives that are strongly counter-optimal to epistemic virtues. A researcher who has taken the time to carry out a well-powered study and has a null finding might find it difficult to publish it. Conversely, a colleague with underpowered studies and cherry-picking a meaningful discovery can end up with a good publication history. This is not a tale of personal moral breakdown; it is a tale of systems that give foreseeable results.

This is the systemic level of Open Science's intervention. Publication bias is directly opposed by registered reports, in which peer review is conducted before data collection, based on the quality of the research question and design rather than the importance of the results. Open peer review, in which the reviewer's identity and comments are publicly accessible, encourages more rigorous and constructive criticism. It is becoming more difficult to hide inconvenient findings as data-sharing requirements are becoming mandatory for funders and journals.

Ramirez and Cayon-Peña (2017) emphasise the characteristics of responsible and productive science, including transdisciplinary approaches and cross-disciplinary knowledge transfer. Open Science helps achieve cross-disciplinary fertilisation by ensuring that findings are shared rather than remaining within the small communities in which they are produced. Data created by an agricultural economist in sub-Saharan Africa, e.g., might be useless to a nutritional scientist, a development practitioner, or a climate researcher addressing a related question, but only when it is available and well documented.

6. Challenges and Critiques

An open-minded adherence to Open Science must admit that the movement has critics and its real challenges. Other researchers fear that compulsory data sharing is unrealistic in areas where data collection is costly and competitive, or where data sharing raises privacy concerns. Others have also noted that open-access publishing has led to a predatory publishing industry, in which journals charge processing fees but offer little editorial oversight. This trend has the potential to compromise research quality rather than improve it.

Incentives are also an issue. Researchers may be requested to preregister, share data, and report null results. Nevertheless, the motivation to adopt such practices is ineffective unless grant bodies, hiring committees, and promotion panels appreciate them. Open Science demands not only the transformation of personal behaviour but also the institutional redressing of the research assessment and reward system, and these changes are gradual and uneven.

Moreover, not only is reproducibility a criterion of scientific value. According to Ramirez and Cayon-Peña (2017), some of the most significant contributions in science are made through exploratory research and discovery-based work, which generate hypotheses rather than test predetermined ones. The strong insistence on replicability as the only hallmark of good science risks underestimating truly innovative inquiry. Instead of giving up on reproducibility as an

objective, it is more appropriate to develop a more advanced conceptualization of the purposes of the different kinds of research and the criteria suitable for each.

7. Open Science in the Context of Development and Agrisciences

The applicability of Open Science is, perhaps, particularly sharp in the context of disciplinary development economics and tropical agrisciences. The work in these areas can be expressly policy-focused: results are meant to guide choices on crop types, land management, nutrition, poverty alleviation, and agricultural extension services, especially in low- and middle-income economies where the impact of poor decision-making is acute. This is one of the environments where research findings scrutiny and replication can have life-altering consequences, rather than being an academic nicety.

External validity has been a thorny issue in development economics: can an intervention that was effective in one environment also be effective in another? The growth of randomised controlled trials as the gold standard of impact evaluation has introduced rigour to many questions. Still, it has sparked significant debate about the applicability of small-scale experimental results to large-scale policy. This type of critical evaluation must rely on open data and open methodology to help the researchers and policymakers evaluate the circumstances in which findings are held and those in which they are not.

In the case of tropical agrisciences in particular, there is a global aspect of Open Science with certain moral connotations. Research institutions in Europe or North America might be able to develop agricultural knowledge with huge implications for farming communities in the Global South. However, the least access to published research is often in those communities. Open Science can reduce knowledge inequalities by implementing open-access policies, establishing data-sharing hubs, and building cooperative research networks worldwide.

8. Conclusion

The trend toward Open Science is, at best, an ethical initiative as much as a methodological one. It claims that the power of science lies in its openness, that knowledge created using publicly available resources is a social property of the people and that the ability to question, recreate and expand the results of scientific discoveries is not a technicality but a requirement for science to be reliable.

In this sense, reproducibility crises are not only symptoms of individual researchers' bad behaviour, although some have been caught. They are symptoms of the institutional arrangements that have gone wrong in the incentives for researchers, with respect to the epistemic and social objectives of science. Pre-registration, data sharing, registered reports, open peer review, and open access publishing are Open Science practices that can be seen as tangible, practical solutions to these misalignments.

It has both personal and professional implications for us, the early researchers, in our careers. The transparency, reproducibility, and commitment to honest reporting, personally, are manifestations of the intellectual honesty whose core we are reminded of in the MIT Academic Integrity Handbook as the cornerstone of all academic work. In the professional domain, working with Open Science norms will place us not as passive observers of the field's acquired customs, but as its redefiners.

Science, according to Ramirez and Cayon-Peña (2017), is never complete. It is not a weakness to be hidden, but an aspect to be shared, developed with integrity, and shared with discipline. Open Science does not offer perfect science. It vows to make it more sincere and, in the process, more truly credible.

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