Innovation Caucus

Funding Innovation through Prizes

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About the Innovation Caucus

The Innovation Caucus supports sustainable innovation-led growth by promoting engagement between the social sciences and the innovation ecosystem. Our members are leading academics from across the social science community, who are engaged in different aspects of innovation research. We connect the social sciences, Innovate UK and the Economic and Social Research Council (ESRC), by providing research insights to inform policy and practice. Professor Tim Vorley is the Academic Lead. The initiative is funded and co-developed by the ESRC and Innovate UK, part of UK Research and Innovation (UKRI). The support of the funders is acknowledged. The views expressed in this piece are those of the authors and do not necessarily represent those of the funders.

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Funding Innovation through Prizes: A Case Study for the UK's Innovation Agency

[SHORT RESEARCH NOTE]

Abstract

This Short Research Note takes the occasion of a spending review by the UK's innovation agency ("Innovate UK") to re-evaluate the theory and practice of funding innovation through prizes. This analysis presents a "state of the art" through developing a taxonomy of innovation prizes; showing when and how they are used in the UK; explaining which tactics from elsewhere should be implemented in UK policy; and identifying what new opportunities exist. This is a single ecosystem study that promotes learning from other innovation environments in order to identify best practices; in particular, it proposes expanded use of Advanced Market Commitments. Ultimately, this examination generates fruitful directions for future research.

Executive Summary

The 'landscape of funding tools' encompasses a broad array of resources that drive innovation. Currently, Innovate UK utilises only a subset of the available tools[1], neglecting a promising mechanism – innovation prizes. Prizes are powerful tools that can garner attention and trigger further investment, especially from private sectors. The Advanced Market Commitment (AMC), a type of innovation prize, can catalyse and stimulate both investment and capacity-building. AMCs offset private investment risks, thus de-risking government innovation initiatives. Innovate UK is in a *unique position* to experiment with AMC, potentially becoming a trailblazer – "standard-setting organization" (SSO) – for novel innovation policy. Nevertheless, the incorporation of prizes to encourage innovation necessitates a rigorous, pre-established impact evaluation system – something that most innovation agents, barring Innovate UK, currently lack. Innovate UK is well-equipped to endorse and measure open-ended, non-linear, transformative innovation.

Context

The UK Government's recently launched Science & Technology Framework[2] is set to invest £20Bn in R&D for 2024-25, in addition to a £250M fund allocated to the Advanced Research and Invention Agency (ARIA)'s "technology missions", a £12M extension to Barclays Eagle Labs, among other expenditures aimed at promoting and incentivizing innovation[3]. The innovation ecosystem challenges businesses to "consider new agile, innovative models such as focused research organisations and practical support for innovators" (informed by the Nurse

[1] Cirera & Maloney (2017). "The Innovation Paradox". https://documents1.worldbank.org/curated/en/322521507638821474/pdf/120336-PUB-PUBLIC.pdf

[2] https://www.gov.uk/government/publications/uk-science-and-technology-framework/the-uk-science-and-technology-framework#investment-in-research-and-development

[3] This report adopts the Bryan & Williams (2021, p. 3) definition: "Innovation is the invention, development, and diffusion of new goods, services or production processes. That is, innovation is the study of how society expands its production possibilities frontier." https://www.nber.org/system/files/working_papers/w29173/w29173.pdf

Review[4]) and promotes "funders experimenting with new approaches" (responding to the Tickell Review[5]).

According to Bryan & Williams (2021, p. 23), research cost reductions can come in the form of tax credits, subsidies, or through awarding market power or payoffs directly via the patent system or prizes, or also "labor market policies such as immigration changes that make it easier for firms to hire specialized workers with expertise in specific technological areas." Historically, innovation incentives were split into interventions that directed the market (i.e., 'push' methods) and others that created it (i.e., 'pull' methods). The University of Chicago[6] suggests this typology of interventions:

Figure 1: UChicago Push & Pull Mechanisms

Push

Funding Design	Criteria
Open competitive research calls – judged by peer review	We do not know what innovations are needed. When we know there is high quality peer review closely aligned to our interests. Good for early stage innovation.
Upfront research contracts – Hiring A to work on product or idea X	Complete information: we know what technology is needed, we know who is best placed to do it and we can either monitor their effort or know how long it should/will take them.
Research contracts – to provide innovation on specific topics	We have a sub-topic of innovation in mind, but do not know the specific technology we want. We know who is best placed to innovate.
Framework agreements – unrestricted support to a research institution	We know the preferences and incentives of the research institution are closely aligned with ours. Or - we know we will occasionally want very small products that are not worth an individual contract
R&D tax credits	When we want to generally encourage all types of innovation.

Pull

Funding Design	Criteria
Patents – temporary monopoly power for innovators	When the returns to innovation are mainly private. Thus, the market is good at prioritizing innovations. For innovations we may not know we need.
Advance market commitments – promising to buy a minimum quantity of a specific innovation	We want a specific innovation and there are incentives to get it used widely without the barrier of monopoly pricing. We do not need to know who would be best placed to invent it. There is (tacit) innovation in the manufacturing.
Milestone contracts – payments linked to achieving specific milestones	We have a specific innovation we want to finance and know specific milestones that must be achieved as steps towards the innovation. Could be firm-specific or competition. Could link to take-up.
Prizes – give a lump sum reward for a solution to problem X	We know the problem we want to solve, and our WTP to solve it. Once solved it can be easily copied by others (e.g. formula). When you don't need an incentive to scale.

To reach its R&D investment target of 2.4% of GDP by 2027, the UK Government can employ more inventive methods to attract private investment for innovation. Innovate UK already utilizes some tools, primarily in collaborative research and development[7]. We believe that prizes could play a significant role as a potent, high-reward mechanism to support this target.

[4] 2023, https://assets.publishing.service.gov.uk/media/6409fda2d3bf7f02fef8832b/rdi-landscape-review.pdf
[5] 2022, https://assets.publishing.service.gov.uk/media/62e234da8fa8f5033275fc32/independent-review-research-bureaucracy-final-report.pdf
[6] Retrieved (24 May 2023) from https://drive.google.com/file/d/1duN2zGyy1_TVe161Rwo4AUpkTC4WGOCJ/view
[7] A recent example, £12 Million total towards "Resource efficiency for materials and manufacturing (REforMM)"
See https://apply-for-innovation-funding.service.gov.uk/competition/1521/overview/44c03277-b4c6-4ee4-90fc-b2ea23a46294

Nesta's (2018)[8] mapping exercise of financial support for innovation produced the "Landscape of Funding Tools". From this, most funders restrict themselves to one or two tools without considering other options that could yield more from their investment (see

Table 1).

[8] https://media.nesta.org.uk/documents/Funding-Innovation-Nov-18.pdf

Table 1: Nesta Landscape of Funding Tools

Funding tool	Description	Advantages	Challenges
Grants	Gift of money, usually linked to commitments on activities, outputs or outcomes.	Simple, established.	How intensively to manage, can drive dependency. No return to funder.
Grants for R&D funding	Stage-gate funding with payments released as product developed/evidence demonstrated.	Suitable for high risk/reward projects.	Requires greater management. Staging can limit project flexibility.
Grants/equity in accelerators in stage-gate	Grants plus small equity shares for new companies, often linked to non-financial help.	Higher success rate for startups.	Intensive input needed to achieve success.
Grants convertible to loans, or grants with royalties	Grants with conditions that make them turn into loans once milestones are met, e.g. on revenues.	Recycles money, drives good behaviours re: financial sustainability.	Requires longer-term engagement to check on revenues and repayment schedule. Modelling of repayment will often be overly optimistic. Can be gamed if repayment triggers are not set right. Tax/accounting treatment not well established.
Grants convertible to equity	Similarly, grants which turn into rights to equity once revenue or other milestones are met.	Recycles money, share of high value projects.	Managing investment, follow-on funding, getting the conversion triggers right. Only feasible if recipients established with shares. Tax/accounting treatment and legal enforceability not well established.
Match crowdfunding	Committing money on condition that matched funding is raised through crowdfunding platforms.	Encourages mobilisation of public money and commitment. Engages wider audience of backers.	Skews to high income audiences; sums still quite small.
Loans	Money lent to be repaid with interest over agreed timescale.	Recycles money. Straightforward offer to recipients. Easy to value cost and likely return.	Managing loan book, risk assessment and security.
Project-specific loans	Loans linked to specific projects, e.g. in technology, repaid only if the projects succeed.	Recycles money. Straightforward offer, attractive to recipient as no repayment if project fails.	Less secure than loans secured against the firm as a whole (see above). Need to monitor project success to see if loan needs to be repaid (this can be gamed).
Convertible loans	Loans offering rights to convert into equity.	Gives lender chance to participate in upside in case of radical success, while still promising repayment in base case.	Can put off future equity investors as carried on recipient's balance sheet. Funder needs to manage conversion process.
Quasi-equity	Loans offering revenue participation rights (e.g. shares of revenue or profit over given levels).	Encourages business growth, recycles more money from successes.	General challenges of oversight and monitoring.

Table 1 cont.: Nesta Landscape of Funding Tools

Impact Bonds (social, development, etc.)	Funding raised from philanthropy or capital markets with commitment of payments linked to outcomes.	Shifts risk from government; encourages focus on evidence and outcomes; can bring in new skills.	Relatively few fields with suitable conditions; still young model in experimental phase.
Venture equity investment (and impact venture investment)	Investment in equity in early-stage companies, usually with aim of significant growth in value and linked to active involvement in management, strategy, etc. Impact investment also aims for social impact.	Funder can participate in upside. Funder gains (some) control in firm. Allows rigorous linking of investment and outcomes (e.g. using standards of evidence).	Intensive management needed for realising value and securing follow-on funding. If funder is charity, link to objects and public benefit must be monitored. Difficult to exit. Average venture capital returns very low.
Intermediary funding	Funding directed through intermediaries (e.g. on Big Society Capital model) which then invest loans, equity, etc., in firms or social enterprises. Usually investors represented on investment committee.	Can increase funding flows (e.g. with co-mingled funds); creates more specialist capacity and some healthy competition. When working well, interest from loans covers management costs.	Sometimes challenges raising matched funds; achieving sufficient scale; and handling timescales of investments and returns.
Challenge prizes	Commitments of funding tied to proof of ability to solve a novel problem.	Good for where market incumbents have little incentive to innovate. Raises awareness and attracts new entrants. Favours technological/product-based innovation.	Challenge of setting the right goal: requires expertise and is difficult to change once set. Success needs to be well-defined. Requires firms to spend money ahead of government funding.
Revenue-based funding models	Releasing grants or loans in response to reaching revenue targets.	Aims to encourage trading and entrepreneurship, as opposed to grant dependence. Used in development, technology, self-employment and other fields.	Revenue results achieved can have many causes, therefore may provide capital where it's not needed; conversely can push recipients to maximise short-term revenue rather than long-term business building.
Golden share	Equity finance linked to a special share which cannot be diluted, or offers special voting rights.	Opportunity to participate in upside without follow-on investment. Gives funder control over firm.	Represents a significant concession for organisation receiving funding. May deter future equity investors.
Services contract to support innovations	Procurement of services from small firms, charities or social enterprises as a way of helping them grow or innovate (e.g. SBIR).	Uses procurement process to support small innovative entities.	Reliance on relatively untried service provider.

[Not shown: "Programme Related Investment" (PRI), which involves "direct investment by a charity that might make a financial return but is solidly aligned to the charity's objects" (Nesta, 2018, p. 50), nor Procurement.]

Although this exercise showed the diversity of options available to public funders, we note that "most funders just use one or two tools and never seriously consider using other ones which could make their money go further," (*emphasis added*). Nesta itself has experimented "such as combining grants with loans or equity, converting grants to loans or grants dependent on matched funding" (Nesta, 2018, p. 16). We argue that, among an arsenal that includes the above mechanisms, prizes are an underused tool that could enable Innovate UK to deliver its core mission of supporting business-led innovation. Dr. Otner argues that *prizes could augment Innovate UK's current funding portfolio and further its mission to support business-led innovation*.

To incentivize the diverse businesses in the economy, a portfolio approach and a mix of different mechanisms are crucial. However, the focus should also be on ensuring a positive return on public investment by encouraging private R&D spend, an essential step to reach the UK government's goal of 2.4% of GDP investment in R&D by 2027 (HM Government, 2020).

Innovate UK's financial support portfolio traditionally has been focused on grant finance for innovation projects. Recently, it has begun to shift towards different finance models to support business-led innovation, incorporating loans projects, loan-grant hybrids, and grant-equity hybrids. For example, Innovate UK has demonstrated its commitment to fostering innovation by investing in skills development and training programs. Another notable program (EDGE Growth support) aims to accelerate innovation by providing valuable support and resources.

Beyond cash purses, prizes can offer more than just financial support; they can spur innovation through capacity-building in training and infrastructure, networking and community-building (of data investment, partners, end users, and stakeholders), business advice, and endorsement & award escalators[9]. Innovate UK's previous engagements with prizes, such as the Young Innovators Award, the Longitudinal Award on Dementia, the Privacy Enhancing Technologies Challenge Prize, and the Newton Fund Prize, show conservative but promising results. Similarly, while mechanisms such as investor partnership programs, which combine grant funding with equity finance from partner investors, offer a more direct approach to leveraging private finance, they can hinder the ability to leverage private finance in a more direct and effective manner. This limitation can restrict access to crucial funding opportunities and impede the overall growth and development of various initiatives or projects that rely on private investments.

Without such mechanisms, organizations and individuals may struggle to secure the necessary financial resources needed to achieve their goals and realize their full potential. We believe that if designed correctly, prizes can stimulate private investment in innovation. Through their experience in delivering on the UK Industrial Strategy Challenge Funds, Innovate UK has gained extensive familiarity with innovation challenges and missions. The organization continues to embrace the spirit of missions and challenges in its approach. Given Innovate UK's role as a Convenor in the innovation system, Grand Challenge prizes therefore align exceptionally well with current working methods and provide an ideal framework for driving innovation forward. We suggest that Innovate UK should consider exploring different types of prizes.

Background[10]: Prizes

Awards are a form of social evaluation that confer a valuable (and thus, desirable) resource upon a candidate, in order to alter their status and thereby set them apart from the majority[11]. The "resource" may be monetary, associated with affiliation (e.g., reputation, endorsement),

[9] See more in Table 3 of Graves, A., Vorley, T. (2023) *Review of Innovation Prizes*. Oxford, UK: Innovation Caucus

[10] For a more detailed breakdown, please see the taxonomy produced in the Graves, A., Vorley, T. (2023) *Review of Innovation Prizes*. Oxford, UK: Innovation Caucus

[11] For an Economics perspective, compare to Frey & Gallus (2017), *Honors versus Money: The Economics of Awards* (Oxford University Press).

access, or any combination thereof. These awards vary in form, encompassing "Most Valuable Player" accolades in sports, Honorary Chairperson and *ex officio* roles, "Lifetime Achievement" celebration, and research grants.

Prizes are a subcategory of awards that denote the recipient as the best embodiment of a given ideal. As a catalyst for innovation, prizes harness the powerful non-monetary motivators[12] of the "desire to establish priority of discovery" (Merton, 1957)[13] and "autonomy" (Merton, 1973)[14]. Indeed, "[t]he sense of curiosity and the idea of fame play a greater part than the economic reward" (Stamp, 1929)[15].) Prizes can yield direct outcomes by addressing the specific mission for which they are established (i.e., innovation in a particular field is sparked by the prize). However, they also provide indirect benefits such as increased patenting (Azoulay, Graff Zivin, Li, & Sampat, 2019[16]; see also Moretti, Steinwender, and van Reenen, 2019[17]) and spur indirect peer effects, wherein innovators can build on the work of prize winners (see Betancourt, Jochem, & Otner, 2023)[18].

The literature primarily discusses four types of innovation prizes: (1) Recognition Prize; (2) Inducement Prize; (3) Grand Challenge; and (4) Advanced Market Commitment. Each prize type has specific attributes, and areas of best practice.

Recognition Prizes

Recognition Prizes, also termed "Blue-Sky Prizes", are awarded *ex post* to honor a specific activity. Prominent examples include the Nobel Prizes, the Academy of Motion Picture Arts and Sciences awards ("Oscars"), The Breakthrough Prize in Mathematics, The Pulitzer Prize for journalism, and The Booker Prizes for fiction. Due to the significant timeline required to establish prestige, Recognition Prizes are sometimes derisorily referred to as "Lifetime Achievement Awards."

Recognition Prizes were the majority format until a major field shift (1991-2007). They typically take the format of an un-restricted monetary "gift", that might or might not be contingent on future activities, outputs, or outcomes – as would be true in the case of a grant. As The Astronomer Royal observed, "compared to usual forms of funding, these prizes encourage mavericks. They can also attract public interest: those in robotics, for instance, can be a spectator sport," (Rees, 2022)[19]. In *ex post* Recognition Prizes, future high-quality innovations might result from the funds given (Moser & Nichols, 2013)[20], but this outcome is not guaranteed. For example, the newly-announced "The Manchester Prize" (of £1M/year for 10 years) celebrating the best work in artificial intelligence is more likely to reify existing status

[12] See related discussion of motivation in open innovation, in Acar (2019), https://doi.org/10.1016/j.respol.2018.11.010
[13] *American Sociological Review*, https://doi.org/10.2307/2089193
[14] *The Sociology of Science: Theoretical and Empirical Investigations* (UChicago Press)
[15] Stamp, Josiah. 1929. *Some Economic Factors in Modern Life*. London: P.S. King & Son, Ltd.
[16] https://doi.org/10.1093/restud/rdy034
[17] NBER, https://www.nber.org/papers/w26483
[18] *Research Policy*, 2023, https://doi.org/10.1016/j.respol.2022.104624
[19] https://time.com/6225572/nobel-prizes-problem/
[20] https://doi.org/10.1111/joie.12030

structures than to spur the "genuinely new and novel, not just disruptive within their sector"[21].

Across UKRI, the majority of the award portfolio comprises Recognition Prizes for research impact and excellence. Although these prizes are not designed *prima facie* to incentivize future innovation, they are hoped to stimulate future development within the same focal area.

Inducement Prizes

In contrast to Recognition Prizes, Inducement Prizes define performance criteria *ex ante*, in order to accelerate innovation towards a specific, pre-defined goal (without restricting either who solves the problem or how they do so). That is, inducements work when expertise exists, but attention needs to be redirected.[22] Recent studies confirm this role: for example, scientific prizes have been shown to yield "extraordinary growth in [academic] productivity, impact, and new entrants" (Jin, Ma, & Uzzi, 2021).[23] Prize winners generate more scientific outputs (such as papers), which in turn are more impactful (measured through accruing more citations), after which the prizewinning topics attract more, new, high-performing scientists to their unsolved puzzles (Jin et al., 2021).

Within the innovation ecosystem, notable examples include The X Prize[24], Impact Canada[25], and Carrot[26]. Crowdsourcing platforms (such as openIDEO, Kaggle, HeroX[27], and Wazoku Crowd[28]) and what Murray et al. (2012)[29] term "Grand Innovation Prizes" also fall under this category. More broadly, and again drawing comparisons to book publishing, The Nine Dots Prize[30] is an example that expands solutions to contemporary social issues.

Since 2007[31], Inducement Prizes have been the dominant format; indeed, most UK termed "Challenge Prizes" belong to this type. They "reward whoever can first or most effectively meet a defined challenge" that is "solvable but not too solvable" (Nesta, 2018, p. 23 & p. 24), with a lump sum payment for an outcome.

Nesta has been instrumental in establishing inducement prizes in the UK. Since 2005, Nesta has pivoted away from supporting individual innovators and towards capacity-building the UK's systems for innovation. These include Venture Builder (capital and support for new and early-stage ventures); Innovation Partner (to design, test, and scale new solutions); and System Shaper (which reduces the typical impediments to scaling). Then, when Nesta became a Registered Charity (2012), the focus has sharpened to only "innovation for public benefit".

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[21] cf. Smart Grants 2023: https://apply-for-innovation-funding.service.gov.uk/competition/1448/overview/304e6f31-0117-44d1-8c2c-4852876a7928
[22] https://entreprenorskapsforum.se/wp-content/uploads/2023/03/WP_68.pdf
[23] https://doi.org/10.1038/s41467-021-25712-2
[24] Active since 1996, https://www.xprize.org/
[25] https://impact.canada.ca/
[26] https://carrot.net/
[27] https://www.herox.com/
[28] https://www.wazoku.com/innovation-360/crowd/
[29] See evaluation in Murray et al. (2012), *Research Policy*, https://doi.org/10.1016/j.respol.2012.06.013
[30] https://ninedotsprize.org/
[31] The US ecosystem followed a parallel timeline. Refer to history in Murray et al. (2012) that highlights milestones such as the National Academy of Engineering (1999) report; the DARPA Grand Challenge (2004) and the America COMPETES Reauthorization Act (2010).

Nesta's Centre for Challenge Prizes launched in 2012 as a full service to both design and administer mission-driven inducement tournaments; when it became a specialist, social enterprise, it became "Challenge Works"[32]. As Nesta focuses more primarily on creating social benefits from innovation, there is scope for Innovate UK to provide a service to core innovation and R&D through prizes.

Grand Challenges

Grand Challenges (a term coined in 2003 by the Gates Foundation) represent high-risk, potentially high-reward projects that are both mission-driven and problem-focused (instead of solution-oriented). Therefore, they are most appropriate when there are clear goals but uncertain pathways to success. The key differentiator of a Grand Challenge from other types of prizes previously discussed is that it is a mixed model, where the ideal output is open-ended with clear stage-gates for scaling, which themselves provide opportunities for interim validation (i.e., identifying quality) and categorization (i.e., identifying failure). These prize funds typically support both initial effort and ongoing development, making these innovation-incentive methods a promising expansion area for innovation intermediaries.

Table 2: Grand Challenge Prize Example: The Earthshot Prize

The Earthshot Prize is designed to discover and foster solutions to repair environmental damage. It combines the portfolio celebration of a Recognition Prize with the requirement for sustained work direction typical of an Inducement Prize.

The Earthshot Prize follows 5 stages:

1) Search: The organisation looks for breakthrough solutions that meet their mission; this is achieved through a network of nominators across the world.
2) Select: Applying pre-defined priorities, a Prize Council filters potential solutions.
3) Accelerate: Finalists are supported to scale their ideas through a tailored programme of support (termed "the fellowship"). This fellowship aims to enable rapid growth, build leadership for long-term growth, and connect innovators to new communities.
4) Award: Five (5) winners will be awarded £1million for the next 10 years, and also join a cohort of 50 previous Earthshot winners
5) Scale: Support does not end after the prize is awarded; instead, prize winners are connected to funders, businesses, and individuals who can help them to grow. [33]

Both Inducement Prizes and Grand Challenges may include "hybrid" payment schedules (e.g., grants at the beginning and end of the tournament) and non-monetary support (notably, coaching) during the competition. For instance, "as an engaged funder, the Nuffield Foundation offers support to shortlisted applicants, helping them to refine their proposals for maximum rigour and impact."[34] Grand Challenge prizes usually incorporate some form of coaching to assist innovators (and particularly, new Principal Investigators) throughout the innovation

[32] https://challengeworks.org/about-us/
[33] https://earthshotprize.org/
[34] https://www.nuffieldfoundation.org/

process. In this regard, Innovate UK's experience delivering the EDGE program is an advantage. While there are distinct differences between the coaching provided by prize Sponsors as they are typically focused on product development (rather than firm development), the broad experience in delivering the early stage support of EDGE would be relevant for prizes.

Advanced Market Commitment

Advanced Market Commitments (AMC)[35,36] are a type of prize launched from the field of Health & Economic Development[37]. They stimulate and incentivize innovation through a prospective guarantee of either subsidy or purchase. While some incorporate a legal commitment (e.g., a legally-binding contract), a "Demand Guarantee" is sufficient. In the realm of book publishing, The Bracken Prize serves as a similar example.[38]

As an economic "pull mechanism", AMCs shift the technological risk to the innovator, while mitigating the eventual demand risk (uncertainty). Overall, "AMCs engage private industry and significantly alleviate the execution risk of government technology agenda," (Ho & Taylor, 2021)[39].

AMCs are appropriate when innovation and implementation are coupled (Sigurdson, 2021)[40] and the target is near (i.e., a 5-7 year timeline for outcome)[41]. AMCs have "three potential elements of a system for triggering reward payments: Fulfilment of technical specifications set *ex ante*; Measures of *ex post* use, willingness to pay, or impact; and *Ex post* discretion … Most mechanisms will use a combination of two or three of these triggers," (Kremer & Williams, 2010)[42]. As such, AMC can incentivize R&D investment and capacity-building.

Therefore, AMCs can encourage R&D investment and capacity-building. AMCs for prizes were suggested as early as 2010[43], but have had limited adoption; thus, their potential to encourage R&D has not been extensively explored. Only as recently as 2022 have AMCs for non-medical solutions started to grow in earnest.

Table 3: AMC Example – University of Chicago Market Shaping Accelerator (MSA) Innovation Challenge 2023

[35] See reflection by Kremer et al. (2020): https://scholar.harvard.edu/files/kremer/files/amc_pp_20_20_01_13.pdf
[36] These are the basis for "Market-Driven, Value-Based Advance Commitments" (MVAC), which scales the contribution based on ability to pay for the new product.
[37] Levine & Kramer (2005), https://www.cgdev.org/sites/default/files/archive/doc/books/vaccine/MakingMarkets-complete.pdf
[38] Formerly known as The Bracken Bower Prize, and backed by *The Financial Times*. https://www.ft.com/brackenbower
[39] *Op Cit.*
[40] https://hdl.handle.net/1807/109052
[41] Ho & Taylor (2021): https://www.belfercenter.org/sites/default/files/2021-06/UsingAdvanceMarketCommits.pdf
[42] https://www.journals.uchicago.edu/doi/full/10.1086/605851
[43] *Op Cit.*

The Market-Shaping Accelerator (MSA)[44] identifies "market failures where the commercial incentives trail," then uses "pull" mechanisms to "increase the private sector's incentives to innovate" by creating demand for these innovations.

The inaugural Innovation Challenge (May 2023-May 2024) has a prize pot of US$2 Million to award for market-shaping proposals, addressing existing market failures in climate change and biosecurity. Of this:

- US$500,000 will reward submissions that define the opportunity (as 125 @ US$4,000 each).
- A small subset of those award-winning proposals will advance to the Accelerator, and share US$400,000 to defray their start-up costs.
- A final subset of projects that succeed through the Accelerator will share US$1.1 Million to seed their campaigns to fundraise the multi-million to billions of dollars required.

MSA accepts submissions from individuals, groups, and organizations. Successful solvers will enter into a grant agreement with the University of Chicago, and prize payment will be made to a single entity.

Table 4: AMC Example – Frontier

In the largest example, Frontier[45] – a consortium of "founding buyers" including Stripe, Alphabet, Shopify, Meta, and McKinsey – has established an AMC of US$1 Billion for a solution that delivers permanent removal of carbon from the environment. The consortium is structured as a public benefit LLC[46].

Frontier have defined 8 criteria for judging the solutions, including durability and land impact measured through physical footprint, in addition to their future potential to balance low-cost and high-volume.

Frontier describe their choice to deploy an AMC as a "bold assist". As illustrated in the Figure below, Frontier will act as an intermediary; it will neither make nor facilitate equity investments.

Figure 2: Overview of Frontier AMC

[44] https://marketshaping.uchicago.edu/challenge/
[45] https://frontierclimate.com/
[46] https://www.wolterskluwer.com/en/expert-insights/benefit-llcs-an-option-for-socially-conscious-business-owners

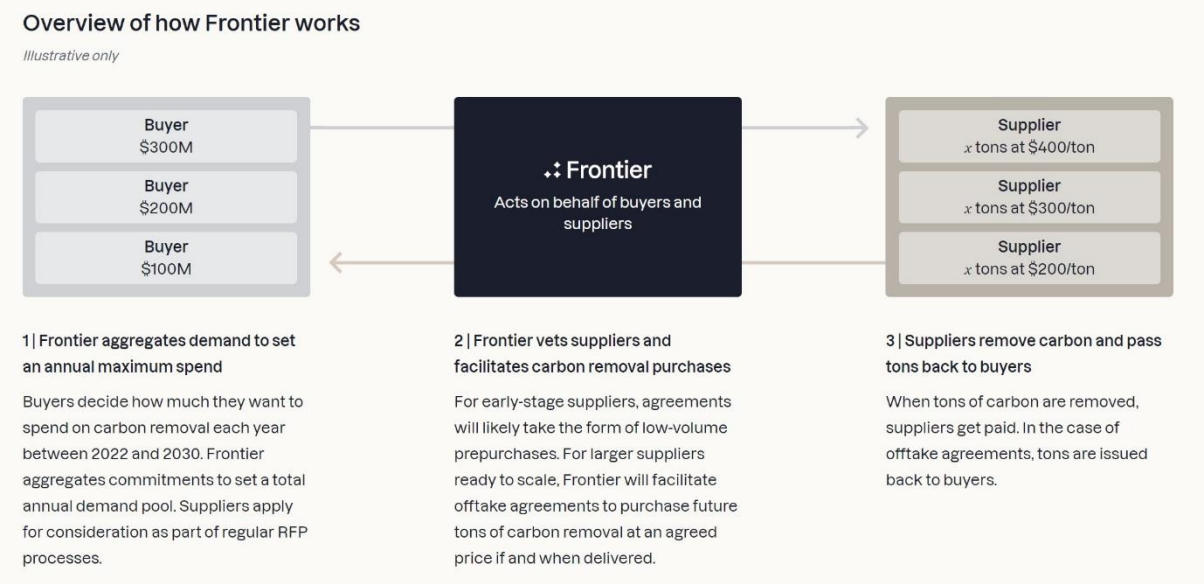

Table 5: UK Example AMC - CivTech Scotland

CivTech – a programme built from the Small Business Research Initiative (SBRI) with input from IUK and initiated by the Scottish government – assembles participants from public, private, and third sectors to address public good issues. It is a compelling example of an Advance Market Commitment (AMC).

Organizations from the public sector and the third sector can propose a challenge, which the CivTech team then evaluates. If a challenge is accepted, the Sponsor must provide a memorandum of understanding, relevant procurement documentation, and challenge videos.

The CivTech programme operates according to the Innovation Flow process:

1. Challenge definition: Challenge sponsors collaborate with CivTech to pose an open-ended question, about a specific problem, without a predetermined solution.
2. Challenge launch and selection: A Call for Proposals is opened, for which everyone is eligible to apply. The CivTech team and the Challenge Sponsors assess the applications. Six (6) applicants are chosen for an interview to advance to the next stage.
3. Exploration Stage: Selected teams work closely with the Challenge Sponsors over three (3) weeks to refine their proposals. This stage is conducted online; participating teams each receive £5,000. Teams are not required to be registered companies at this stage, but IP[47] must be allocated to an entity chosen by the participants.
4. Accelerator Stage: The focus is on swift product development, with teams working alongside Challenge Sponsors to create a minimum viable product (MVP) over 15 weeks. Each team receives £30,000. Teams are required to form an official company at this stage. The participant Company retains IP rights, and neither CivTech nor the Challenge Sponsors take equity.
5. Demo Day: This is a chance for teams to showcase their products to an interested audience. The 2021 event attracted over 1,000 attendees. While successful MVPs are already on the

[47] Consider discussion in Murray et al. (2012, pp. 1787-8) of the complementarity between IP rights and prizes.

path to a contract with their Challenge Sponsors, the demo day offers an opportunity to reach a broader audience.

6. Pre-commercialization Stage: Participants can continue their association with challenge Sponsors. Once the product is commercially viable, the challenge Sponsor obtains a perpetual royalty-free license. Funding for post-commercial development should be sought from other sources. Contracts with challenge Sponsors typically range up to £210,000 or £610,000.

Overall, because they offer a "clear line of sight to scale" (Nesta, 2018, p. 9), AMCs satisfy the need to "reflect the importance of obtaining economic benefits from public funding, and the potential for successful commercialisation, growth and exports".[48] Thus, implementing AMCs for innovation could potentially transform Innovate UK into a "standard-setting organization [SSO]" (refer to Tim Simcoe's work)[49].

Benefits of Prizes

Nesta (2018, p. 23) categorized three core benefits that prizes deliver to their focal areas:

- **Create better solutions**: Prizes incentivize new thinking and reward the best solutions, wherever they come from, however they work.

- **Bring together innovators and help them thrive**: Prizes help innovators by providing access to information, ideas, profile-raising opportunities, investment and expertise.

- **Unlock systemic change**: Prizes raise awareness, inform policy, and shape the future of markets and technologies

Prizes effectively employ an open innovation approach, inviting fresh perspectives, novel approaches, and a diverse set of participants – what Murray et al. (2012, p. 1779) described as "harnessing unusual stakeholders across unexpected bodies of expertise" – all of which enhances the variety of innovators and their solutions. Unlike more traditional innovation incentives such as grants or baseline tax credits, prizes direct attention[50] in a manner that can shape markets and re-orient industrial activity. Recent evidence[51,52] (Kudymowa et al., 2022)[53] suggests that prizes deliver multiplicative leverage from capital (e.g., increased R&D expenditure consequent to initial investment)[54], relative to the size of the prize purse. A

[48] https://apply-for-innovation-funding.service.gov.uk/competition/1448/overview/304e6f31-0117-44d1-8c2c-4852876a7928
[49] https://doi.org/10.1257/aer.102.1.305
[50] See detailed treatment in Murray et al. (2012), *Op Cit*
[51] Ansari X Prize induced 10x total R&D investment, as reported in Newell & Wilson (2005), https://www.rff.org/documents/1283/RFF-DP-05-33.pdf
[52] DARPA Grand Challenge induced 50x investment, as reported in Schroeder (2004), https://www.keionline.org/misc-docs/IP_11_2004.pdf
[53] https://forum.effectivealtruism.org/posts/xanSjg6Hq2PaGEkZP/how-effective-are-prizes-at-spurring-innovation
[54] https://challengeworks.org/reports/attracting-investment-with-challenge-prizes/

primary source of this comes from the innovator-competitors themselves, who usually invest (both effort and funds) in aggregate more than ten times the value of the monetary award[55,56]

A 2021 Nesta white paper[57] highlighted how prizes can attract increased investment, primarily through building credibility and visibility. Given the Government's ambition to work "with industry and philanthropic partners to increase inward investment," prizes are a fitting mechanism for achieving this aim. In addition to the benefits identified by Nesta, in general, prizes' ability to garner prestige can be an attractor to those businesses who may not apply for typical grant funding or loans.

Furthermore, within individual prize types, there are distinct benefits. For example, employing a stage-gated approach (as typically used in both Inducement Prizes and Grand Challenge prizes) can negate some of the effect of "fundable, but not funded" phenomena seen in grant competitions, where projects can rank highly but not be awarded[58]. As the cash for prizes can fund more eligible projects at the start, the costs of developing an idea are not solely borne by the applicant.

Considerations for Deploying Prizes

There are a few core considerations for deploying prizes to incentivize innovation[59].

Primarily, there is the set of "known 'errors'," (Nesta, 2018, p. 9):

> The first is insufficient focus upstream. Too little attention is paid to preparing the ground, sharing ideas and evidence, and helping the people who are developing ideas at an early stage to develop better ones. This failure to curate, encourage and educate generally means that applications are lower quality, less inspired and less aware of what others have tried. Nearly always, more upstream work pays off, even though this might be seen as an unnecessary cost.

Indeed, the Operating Expense for a prize competition can be the same or greater than the value of the prize purse[60]. Associated costs include (but are not limited to): Research & Design; Stage-Gating (i.e., multiple application periods with multiple judging processes, requiring administration, governance, and financial teams); Non-Financial Support; Technical Testing & Validation; Publicity (for Innovators, as well as prestige-building for both the Sponsor and the Operator); and Evaluation & Impact Tracing.

[55] http://www.mckinsey.com/app_media/reports/sso/and_the_winner_is.pdf
[56] See in-depth analysis in Kay (2012), *Technological Innovation and Prize Incentives: The Google Lunar X Prize and Other Aerospace Competitions*.
https://www.e-elgar.com/shop/gbp/technological-innovation-and-prize-incentives-9781781006474.html
[57] https://challengeworks.org/reports/attracting-investment-with-challenge-prizes/
[58] Otner (2018): https://journals.sagepub.com/doi/pdf/10.1177/105649261773771 1
[59] See Challenge Works' (2019) best practice review for more detailed guidance:
https://challengeworks.org/reports/nesta-challenges-practice-guide-2019/
[60] This information typically is commercially sensitive between the prize Sponsor and the prize Operator. Competitions for which IUK should have this information include the Longitude Prize on Dementia, the Longitude Prize on AMR, and the Legal Access Challenge.

In addition to monetary support, the total time investment required to design and implement a prize competition, to award a prize, and then to assess its impact might not align with an external funder's typical program timeline.

Secondly, aiming to "reach a socially-optimal level of incentive for innovation", it is vital to consider how any intervention (i.e., establishing a new prize) influences behavior. Introducing a new award necessarily increases competition for it – and likely escalates fractiousness in the wider field. Given the current high level of fragmentation and rivalry, is it optimal to heighten competitive behaviors? If not, how can we structure innovation incentives[61] to foster co-opetition[62]? Some opportunities (including the Deep Space Food Challenge[63] & the Deep Space Healthcare Challenge[64] (both jointly sponsored by NASA and the Canadian Space Agency), and HM Treasury's Affordable Credit Challenge[65]) actively encourage cooperation – either through fostered interactions, or mandatory joint ventures, or including collaboration within their scoring metrics, or other mechanisms. However, due to their newness, their effectiveness has not yet been evaluated.

Lastly, it is crucial to consider the organizational ecology[66] – i.e., the broader effects on the field (not just a single actor or segment) – consequent to introducing a new award. As innovators' attention is finite, launching a new prize would inevitably divert focus, possibly reducing efforts on existing competitions and prior priority areas. This contrasts with an uninformed "rising tide lifts all boats" approach that assumes more money is universally desirable and beneficial. There might also be unmodeled upside risks.

Prizes within Innovate UK (*Status Quo*)

Since its inception, Innovate UK has provided targeted grant support for innovation projects within registered firms. The organization has experimented with new models of financing business-led innovation – including piloting loans, loan-grant hybrids, and grant-equity hybrids – along with initiatives to accelerate innovation skills development (e.g., the EDGE Growth programme). IUK's experience delivering the Industrial Strategy Challenge Fund has shaped UKRI's recently-announced mission fund[67].

Innovate UK has participated in collaborations that used prizes to incentivize innovation – including the Young Innovators Award, the Longitude Prize on Dementia, Women in

[61] Refer to discussion of rivalry in Boudreau et al. (2011), *Management Science*, https://doi.org/10.1287/mnsc.1110.1322

[62] Brandenburger & Nalebuff's term for "cooperating with a competitor to achieve a common goal" See https://hbr.org/2021/01/the-rules-of-co-opetition

[63] https://www.deepspacefoodchallenge.org/

[64] https://impact.canada.ca/en/challenges/deep-space-healthcare-challenge

[65] https://www.nesta.org.uk/project/affordable-credit-challenge/

[66] "Organizational Ecology" is a sub-field of organization studies that unites biology, sociology, and economics to understand the lifecycle of an organization within its wider field. Principally, it concerns the birth, change, and death of organizations.
Core texts include Hannan & Freeman (1977, http://www.jstor.org/stable/2777807) and the consequent book, Hannan & Freeman (1989, https://www.hup.harvard.edu/catalog.php?isbn=9780674643499)

[67] https://www.ukri.org/news/250m-to-secure-the-uks-world-leading-position-in-technologies-of-tomorrow/

Innovation Awards, the Privacy Enhancing Technologies Challenge Prize, and the Newton Fund Prize. However, to date, it has not directly engaged prize tournaments.

Table 6: IUK Example – The Young Innovators Award

Delivered through Innovate UK's Knowledge Transfer Network (KTN), EDGE, and the Catapult Network, the Young Innovators Award is a Grand Challenge prize aiming to "change the world by investing in young people with big environmental, societal, and economic ambitions[68]. The award combines a £5000 purse (intended to reimburse project costs *ex post*), development (e.g., one-to-one coaching), and a unique mechanism with which to provide living costs (*ex ante*, thereby encouraging socioeconomic inclusivity).

Table 7: IUK Example – The Privacy-Enhancing Technologies (PET) Challenge Prize

Innovate UK contributed to this global initiative[69] (alongside the US National Science Foundation, the White House Office of Science and Technology Policy, and the National Institute of Standards and Technology), offering a combined prize purse of £1.3M/US$1.6M. The stated aim[70] was "to accelerate the development and adoption of privacy-preserving federated learning approaches, and build trust in their adoption." The Challenge progressed across three phases, with £10,000 per project awarded in restricted funds to support business growth, and £50,000 per project solely for solution development. The total available was £700,000, and solutions should now[71] be in the final, "Testing" phase.

Evaluation

For the effective implementation of prizes to incentivize innovation, pre-planned, robust impact evaluation is essential. Given their origin outside of government and their public funding source, their design must align with, but is not restricted to, The Magenta Book's guidelines.[72] In addition, UKRI[73] and Innovate UK[74] each have existing evaluation instruments. However, a number of key performance indicators (such as "advance commercialization … through investment" or "product optimization") do not specify their thresholds for success.

Moreover, neither of these frameworks investigates increased visibility (e.g., "profile-raising"); nor capacity-building; nor assessments of creativity & innovativeness fostered/generated. [Regarding the latter, currently the only measure is quantitative and of intellectual property

[68] https://iuk.ktn-uk.org/programme/young-innovators/&sa=D&source=docs&ust=1682502907431696&usg=AOvVaw1TFijmhEm1AgCMb2Q1ICJi
[69] https://petsprizechallenges.com/
[70] https://apply-for-innovation-funding.service.gov.uk/competition/1256/overview/e77ce7f8-3395-4dd3-95ec-e13880056373
[71] As of June 2023
[72] https://www.gov.uk/government/publications/the-magenta-book
[73] https://www.ukri.org/councils/innovate-uk/guidance-for-applicants/project-impact-guidance/what-the-project-impact-questions-cover/#contents-list
[74] https://www.ukri.org/publications/evaluation-framework/

(i.e., number of new patents filed).] This omission restricts our understanding because, as primary research suggests[75,76], innovators value these non-monetary outcomes more than the prize purse; indeed, "incentives are more nuanced than recognized by theorists or prize advocates" (Murray et al., 2012, p. 1780). Moreover, Murray et al. (2012, pp. 1781-2) proposed an evaluation framework for Grand Innovation Prizes – which seems to have been ignored. That should be expanded to include the considerations raised herein, and then actually applied.

Organizations that deploy prizes for innovation and the stakeholders competing for them often define distinct "success" outcomes, mainly: (1) increased innovation; (2) increased investment (i.e., R&D activity); (3) increased user satisfaction; (4) improved user involvement (i.e., leveraging the open innovation approach to engagement and co-creation); and (5) improved visibility/awareness of a particular problem. Thus, evaluating the implementation of prizes to boost innovation must address: "What is required for open-ended, non-linear, transformative innovation?"[77,78]

Opportunities

Government Evolution

The new Science & Technology Framework presents some opportunities that are ideal for prizes. For example, "investing in a research cloud pilot and giving researchers greater access to data from a range of sources through the Office for National Statistics Integrated Data Service" is a fertile ground for a Grand Challenge.

> It's crucial to deploy resources optimally and to offer novel incentives—in money, prestige and satisfaction—to research groups and to encourage the aspiration of the younger generation to develop and apply their talents to enhance human benefit and understanding," (Rees, 2022)[79].

In a second example, as The Vallance Review seeks "opportunities and enablers for digital technologies, life sciences and green industries", Inducement Prizes are (and have always been) a natural fit. Moreover, these present a new prospect to introduce Advanced Market Commitments (AMC) for non-medical outputs. The transition from Industrial Strategy to Innovation Strategy[80] and the recent division of BEIS into The Department for Science, Innovation and Technology & The Department for Business and Trade, together are likely to affect the existing innovation incentives and infrastructures (support) for businesses – and prizes can fill this gap. Moreover, given the role of missions in the Innovation Strategy, mission-focused awards like prizes thus become directly relevant.

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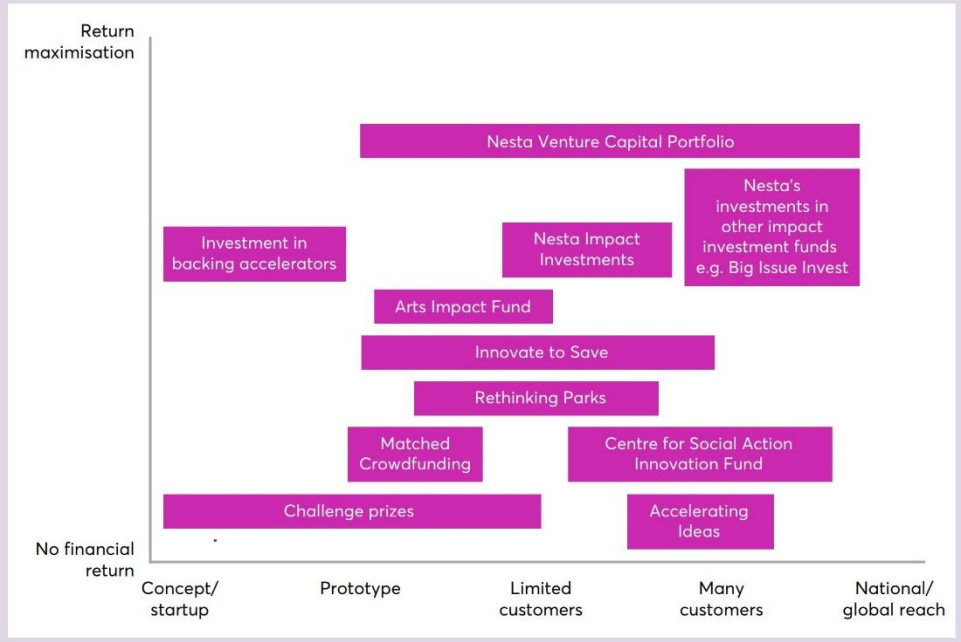
[75] Otner, S. M. G. & Roberts, J. (2020). Program Evaluation of Nesta Challenges. Available on request.
[76] DFID "Ideas to Impact" Evaluation: https://assets.publishing.service.gov.uk/media/5f3fe1c1e90e0752a6e84ce3/Evaluating_the_value_for_money_of_Ideas_to_Impact_s_innovation_inducement_prizes__1_.pdf
[77] Thanks to Vidal Kumar (Evaluation Manager at Challenge Works) for this wording.
[78] Some work in this area has started at UCL's Institute for Innovation and Public Purpose (https://www.ucl.ac.uk/bartlett/public-purpose/ucl-institute-innovation-and-public-purpose) & its Mission-Oriented Innovation Network (MOIN).
[79] https://time.com/6225572/nobel-prizes-problem/
[80] 2021: https://www.gov.uk/government/publications/uk-innovation-strategy-leading-the-future-by-creating-it

Mapping the IUK Funding Portfolio

Examining the current collection of innovation incentives, in terms of "Reach" versus "Return," would be beneficial. Nesta (2018) mapped its portfolio using this approach:

Figure 3: Nesta's Funding Portfolio (Reach vs. Return)



Performing a similar exercise for Innovate UK could reveal opportunities for alternatives – such as Advanced Market Commitment, and experimentation for "innovation in innovation" – not currently used.

Future Avenues for Research

Experimentation

"We need deliberate experiment with new ways of using money – including ways of combining public, philanthropic and private money – and faster learning to find out what works at different stages of the innovation journey," (Mulgan, 2017)[81]. Adhering to the "No Detriment" Principle and measured against the counterfactual of inaction, experimentation should start with an evaluation-inclusive design. The two most comprehensive compendia of best practices are found in The Experimenter's Inventory (from the Alliance for Useful Evidence, 2020)[82] and in The Experimental Research Funder's Handbook (from the Research on Research

[81] https://www.nesta.org.uk/blog/social-innovation-the-last-and-next-decade/
[82] https://www.nesta.org.uk/documents/1722/Experimenters_Inventory.pdf

Institute, 2022)[83,84]. Dr. Otner has proposed[85] a series of such field experiments with prizes, including actions focused on near-winners (i.e., high-performing non-winners; Otner, 2018)[86] and governance (e.g., judges; evaluation).

Research Questions

- Despite this review's thoroughness, given the publicly available information, opportunities for future exploration persist. Using qualitative research techniques[87], what visibility and capacity-building levers do participant Solvers value?
- How do we define "effective" visibility, and how do we measure it?
- To what degree of complexity, and also to which Technology Readiness Level (TRL)[88], are Advanced Market Commitments most suited?
- Beyond including "collaborative" in the scoring of submissions, how might prizes be designed and delivered in order to optimize cooperation (among Solvers)?
- How do operational costs of a prize compare with those of alternative innovation mechanisms?
- If a prize had not been deployed, what other investment might have occurred?[89] In other words, what is the best estimate for the additionality of prizes for innovation? What is the deadweight (i.e., loss from inefficient allocation; displacement or substitution)[90]?
- Is "future funding attracted" still the most appropriate measure of a prize's impact on R&D?
- What is the role for backward-looking Recognition Prizes?
- For example, the newly-announced "The Manchester Prize" (of £1M/year for 10 years) celebrating the best work in artificial intelligence is more likely to reify existing status structures than to spur the "genuinely new and novel, not just disruptive within their sector"[91].
- Accessing near-winner (Otner, 2018)[92] and other unsuccessful Solvers[93] to collate the same evidence that we have from successful innovators.

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[83] https://rori.figshare.com/ndownloader/files/36068099
[84] See work from other national agencies – for example, Finland's SITRA: https://www.sitra.fi/en/publications/the-practices-of-challenge-driven-innovation-challenge-design-implementation-evaluation-and-funding/#publication-content
[85] Previous (2019) submission to Innovate UK; available on request.
[86] https://doi.org/10.1177/1056492617737711
[87] Dr. Sarah Otner & Dr. Jessica Roberts (2020) evaluated the Nesta Challenges Programme, using these methods and similar research questions.
Report available on request from the author, with permission from Challenge Works.
[88] https://www.ukri.org/councils/stfc/guidance-for-applicants/check-if-youre-eligible-for-funding/eligibility-of-technology-readiness-levels-trl/
[89] To answer this, the Research Question might be: "To what extent would the investment in R&D have been smaller/larger/the same *without* participation in this prize competition?"
[90] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/32281/12-767-assessing-deadweight-loss-with-investment-further-education.pdf
[91] cf. Smart Grants 2023: https://apply-for-innovation-funding.service.gov.uk/competition/1448/overview/304e6f31-0117-44d1-8c2c-4852876a7928
[92] https://doi.org/10.1177/1056492617737711
[93] Piezunka & Dahlander (2014), *Academy of Management Journal*, https://doi.org/10.5465/amj.2012.0458

Conclusion

Innovate UK already plays a prominent role as a Convener in the UK innovation ecosystem, established through adopting a variety of measures from the “innovation toolkit”. However, prizes, particularly Advanced Market Commitments, are the least utilized. Implementing these, and joining the likes of the University of Chicago and Stripe in these such "bold assists," would solidify IUK's position as a standard-setting organization among innovation agents.