

# Unlocking Smart Data: Design Research into a Possible Smart Data Challenge Prize

Literature Review on Challenge Prizes

Literature review conducted by <u>Challenge Works</u> (a Nesta enterprise) and <u>DeepSeer</u> on behalf of the Department for Business and Trade

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#### 1. Introduction

#### 1.1. Context for this Challenge Prize literature review

This literature review was provided to the Department for Business and Trade (DBT)¹ by the Nesta Challenge Works and DeepSeer partnership as part of a Phase 1 deliverable in a three-phase research project "Unlocking Smart Data: Design Research into a Possible Smart Data Challenge Prize". This project took place between December 2022 and March 2023.

By way of context, the purpose of the research project overall was:

"to improve government understanding of feasible design and delivery options for a possible Smart Data challenge prize. This will help ensure that we [DBT] can make an informed decision on whether a challenge prize would meet our aims and objectives and offer value for money" (from tender documentation)

The overall aim of the possible challenge prize itself would be "to identify and incentivise the development of a range of new detailed cross-sector use cases for Smart Data". The intention is that this will "illustrate the potential value of Smart Data, and [enable government to] better understand the challenges that would need to be overcome to facilitate cross-sector data sharing" and in turn "encourage innovation and investment in the development of Smart Data schemes".

DBT's overarching ambition in relation to Smart Data is "to grow and accelerate the delivery of new Smart Data schemes and increase cross-sector interoperability".

#### 1.2. Purpose of this literature review

This is a review of the academic and grey literature on challenge prizes, with a focus on literature that is most relevant to a possible Smart Data challenge prize. This review draws conclusions from the literature on challenge prizes and how to deliver them effectively, as well as assessing how confident readers can be in this evidence base. The key objective of the review is to draw out lessons on what good looks like in challenge prize design and delivery, and the practical implications for the possible Smart Data challenge prize. The conclusions drawn from the literature, including in relation to key evidence gaps, were used to inform the next phases of the research project focused on design option development.

The key research questions explored in this literature review are:

- How are challenge prizes situated within the innovation landscape? (Section 4)
- In what circumstances are prizes effective and why? (Section 5)
- What design variables are used to drive outcomes from prizes? (Section 6)
- What practical implications can be drawn from the challenge prize literature for a possible Smart Data challenge prize? (Section 7)

<sup>1</sup> Formerly the Department for Business, Energy and Industrial Strategy (BEIS), prior to February 2023.

#### 2. Methodology

#### 2.1 Scope of review

This literature review focuses specifically on challenge prizes (innovation inducement prizes), where the aim is to induce investment in or focus attention on meeting a specific goal or developing a technology. In particular it focuses on findings relating to:

- Theory and evidence about scenarios in which challenge prizes are effective, and how to design prizes to be more effective in specific contexts
- Data relating to impact and application of challenge prizes in practice

This review explicitly excludes prizes that do not focus on innovation and recognition prizes (e.g. the Nobel Prizes).<sup>2</sup> It also does not cover all of the literature relating to theoretical models of challenge prizes, as discussed further below.

#### 2.2 Sources of evidence

The literature was sourced and selected for this literature review using the following approach:

- 1) The first sources analysed were previous reviews of the literature (academic and grey literature), the most comprehensive of which is a review by Abdullah Gök from Manchester Institute of Innovation Research which surveyed 19 studies on the impact of challenge prizes, including academic studies and non-academic assessments of prizes run by independent bodies (Gök et al.).<sup>3</sup>
- 2) Further literature was sourced from Google and Google Scholar searches, using the following search terms which were derived from the research scoping process:
  - "innovation inducement prize(s)"
  - "challenge prize(s)"
  - "innovation competition(s)"
  - "innovation challenge(s)"

This includes sources from the following areas, the relative merits and limitations of which are discussed below:

- Academic literature: Peer-reviewed journal articles and review papers
- **Grey literature:** Documents and studies published for example by government, academia, research organisations and consultancies outside of commercial publishing channels
- Practitioner insights: Published toolkits, guides, perspectives and impact evaluations of challenge prizes by practitioners

Searches were also carried out for literature relating to any Smart Data focused challenge prizes using the following search terms:

"challenge prize(s)" + "smart data"

<sup>2</sup> Recognition prizes are prizes that are conferred based on past achievements. By contrast, challenge prizes aim to induce new achievements.

<sup>3</sup> A revised version of this work was published by the authors in a 2016 book chapter on the same topic (Edler et al.).

- "innovation inducement prize(s)" + "smart data"
- "innovation competition(s)" + "smart data"

However, no relevant sources were found which covered this intersection (other than references to the DBT tender for the research project of which this literature review is part). While there are references to challenge prizes relating to Smart Data, such as the Open Up Challenge and Open Up 2020 (both challenge prizes designed and delivered by Challenge Works), this lack of literature sources demonstrates the small number of historic prizes in this space or research relating to challenge prizes that are specifically focused on Smart Data.

In addition to the Open Up Challenge and Open Up 2020, other Smart Data challenge prizes or similar initiatives have been run, including:

- The Global Open Finance Challenge,<sup>4</sup> a two month event that took place in October/November 2021 sponsored by four banks. The Challenge provided access to "four sandboxes [...], which include a combination of open banking, open finance, and experimental services", with each sandbox providing access to APIs of one of the four banks and "enabling participants to test the APIs in an experimentation environment, plus use these resources to build and validate their innovations for the Challenge".
- Nationwide's Open Banking for Good initiative which was launched by Nationwide Building Society in 2018 and ran throughout 2019 into early 2020.
- 3) Those publications sourced by searches were then sifted before analysis. Given time constraints and to avoid replicating previous work, a decision was made to focus on publications since 2016 (when the review by Gök et al. was carried out), to cover the period after this existing review. As discussed in the below section on limitations, a fuller systematic review would have included closer scrutiny of literature before this milestone. References within the chosen timeframe were then sifted based on relevance to the research questions outlined in Section 1.2, based on the article title and abstract to identify the main theme of the article.
- 4) The literature selected to be in scope was then analysed and critiqued to determine its quality and validity based on the strength of the experimental and/or theoretical approach taken, including the existence or not of counterfactuals, size of sample (in the case of impact evaluations) and similarity of simulations to real prize approaches used in practice (in the case of theoretical models).

#### 2.3 Academic literature

The largest body of academic literature on prizes relates to theoretical discussions relating to prizes as a funding mechanism as contrasted with patents. These are discussed briefly herein but do not form a focus of the present review. There are relatively few academic works that study the impact of prizes on the creation of innovation outputs (i.e. whether prizes lead to increased levels of innovation or more innovative solutions relative to other funding mechanisms, measured in terms of e.g. increased patent outputs), and even fewer which demonstrate genuine additionality i.e. whether these effects would have happened anyway or what would have happened with an alternative prize design or another innovation policy measure (<u>Murray et al.</u>, <u>Williams et al.</u>). Further detail on the availability of academic literature around prize impacts is provided in Section 5 in this review.

#### 2.4 Grey literature and practitioner insights

As noted, the availability of rigorous impact evaluations on prizes remains limited and this extends to the grey literature. McKinsey & Co reported in 2009 that more than 40% of prizes were not

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<sup>4</sup> https://www.globalopenfinancechallenge.com/ (accessed 9 February 2023)

evaluated for their impact and those evaluations that did exist were largely ad hoc. There are a few evaluation reports carried out during or after the launch of a prize, and these are included herein.

Challenge prizes as a method are broad and poorly defined in scope. This creates challenges in measuring defined outcomes and impact of challenge prizes in relation to other innovation funding methods.

There is however a growing number of case studies from prizes run by Challenge Works and other practitioners (e.g. NASA, Kaggle and XPrize). Many of these have been discussed in the grey literature published by government, funders and other wider stakeholders, including research organisations and consultancies. We have included the most relevant and reliable sources here, chosen based on quality of research design, given the importance of including the wider grey literature to reduce publication bias for a more balanced analysis (Paez et al.).

#### 2.5 Limitations of approach

It should be noted that this work does not constitute a full systematic review due to the time constraints within which it has been undertaken and the specific wider purpose to which the literature review is intended to contribute. The focus on existing literature reviews enabled some shortcuts to be taken in the generation of sources, but it is acknowledged that this may also build in potential bias and blind spots by relying on the thoroughness and objectivity of these previous authors, for example through preferential inclusion of literature by the authors' colleagues and/or other factors such as the authors' geography. The search terms used were chosen to cover most of the relevant literature, but it should be noted that alternative language is sometimes used to refer to challenge prizes, and therefore the search terms used may not have been fully exhaustive.

#### 3. Smart Data Context

#### 3.1 Smart Data

DBT defines Smart Data as the secure sharing of customer data with Authorised Third Parties (ATPs), upon the customer's request. These providers then use this data to provide innovative services for the consumer or business user, such as automatic switching or better account management.

Smart Data can generally be characterised by requirements beyond the UK GDPR right to data portability, by requiring data holders to:

- Provide data to customers or ATPs on a continuous or periodic basis, following a request from a customer. UK GDPR stipulates portability requests are 'one-off' and must be met within 30 days.
- Provide data securely via Application Programming Interfaces (APIs), or equivalent secure methods, and only once the ATPs have authenticated the customers' identity and received their consent.
- Provide data broader than "personal data" as defined under UK GDPR, including product and performance data, such as standard pricing data, and customer data, and data on their household consumption of a service.
- Similarly, data holders must provide data at the request of individuals and businesses (where a business is a customer), rather than simply individual "data subjects"<sup>5</sup>.
- Adhere to common or consistent technical standards, guidelines, and/or data formats to ensure
  interoperability and to minimise barriers for ATPs. Standards may require the use of Application
  Programming Interfaces (APIs) to provide data. APIs ensure data shared by the data holder is
  provided in a secure, standard format that is ready to use by an ATP's app or service.
  - Data provided under UK GDPR needs to be "structured, machine-readable, and interoperable". In practice, this could simply mean a spreadsheet database of raw personal data that is not readily usable by customers or ATPs.

By combining customer data with product and performance data, facilitated by an interoperable framework for data sharing, innovators will have the opportunity to develop new ways for consumers and businesses to benefit from their data.

This specific definition of "Smart Data" is used in large part by the UK government, or in research commissioned by the UK government, and is not universally adopted. For example, other jurisdictions (e.g. the EU and Australia) have adopted different terminology for similar schemes. In the commercial sector and in the academic literature the term "smart data" is used quite loosely (often to mean simply "data from which useful insight can be gained" or synonymously with "big data") and rarely with the UK government's specific definition.

#### 3.2 Status of UK Smart Data schemes

As set out in the BEIS (2022) "Regulatory Powers for Smart Data Impact Assessment", public sector-led Smart Data schemes exist at varying stages of development. The schemes that are progressing at the quickest pace are underpinned by a legislative mandate for industry participation - Open Banking (under the CMA Retail Banking Order) and the Pensions Dashboard (under The Pension Schemes Act 2021):

<sup>5</sup> Data subjects are defined in UK GDPR as "the identified or identifiable living individual to whom personal data relates." Information Commissioners Office, legal definitions.

- Open Banking: As of writing, Open Banking is by far the most significant and advanced Smart Data scheme in the UK. The Open Banking scheme covers bank accounts and credit cards for the UK's largest banks and building societies. The scheme incorporates both read functionality (e.g. to request account information, such as the transaction history) and write functionality (payment initiation). The Open Banking scheme was mandated by the Competition and Markets Authority (CMA), with the development of the scheme led by the Open Banking Implementation Entity (OBIE) created specifically for that purpose.
- Smart meter data sharing: The Data Communications Company (DCC), which operates the secure telecommunications network that connects smart meters to energy suppliers, provides access to customer smart meter data, at the customer's request, to authorised third parties. This arrangement is used by consumer apps such as Bright and Loop to provide insight to consumers about their energy usage. While this arrangement is not described by DCC as a Smart Data scheme, and may not strictly meet all the requirements listed above to count as a Smart Data scheme, it is in our opinion at least Smart Data-adjacent.
- Pensions Dashboard: Pensions providers will be compelled by legislation (the Pensions
  Dashboards Regulations 2022, for occupational pension schemes; FCA rules for providers of
  personal and stakeholder pensions) to compulsorily connect to the pensions dashboards ecosystem.
  Large pension providers (those with 1,000 or more active and deferred members) are in the first
  wave.
- Other consumer data-sharing schemes: Potential Smart Data schemes in financial services beyond the coverage of the existing Open Banking scheme (e.g. to cover savings, investments, insurance), in telecoms and in retail energy have been discussed in various fora and at various times since the Midata scheme was first announced by the UK government in 2011.
- Ofgem was exploring a consumer data-sharing scheme called Midata for a number of years, but this
  programme has been paused since 2020.<sup>6</sup>
- The FCA undertook a "Call for Input" on open finance between December 2019 and October 2020, publishing a feedback statement in March 2021.<sup>7</sup>
- Ofcom undertook a consultation on the potential future introduction of a 'data mobility' initiative in the retail telecoms and pay TV markets in late 2020, publishing its conclusions in July 2021.8

In March 2022, HM Treasury, the Competition and Markets Authority (CMA), the Financial Conduct Authority (FCA) and the Payment Systems Regulator (PSR) announced the creation of a new Joint Regulatory Oversight Committee (JROC). The key objectives of JROC are "developing the vision for the future of Open Banking and to make recommendations on the design of the future Open Banking entity".<sup>9</sup>

The government is seeking powers to extend its ability to establish and mandate participation in Smart Data schemes across the UK economy, within Part 3 of the Data Protection and Digital Information (DPDI) (No.2) Bill.<sup>10</sup> This was introduced on 8 March 2023.

<sup>6</sup> See for example https://www.ofgem.gov.uk/energy-policy-and-regulation/policy-and-regulatory-programmes/midata-energy-programme

 $<sup>7\</sup> https://www.fca.org.uk/publications/feedback-statements/fs21-7-open-finance-feedback-statement$ 

<sup>8</sup> https://www.ofcom.org.uk/consultations-and-statements/category-1/open-communications

 $<sup>9\</sup> https://www.gov.uk/government/publications/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-future-of-open-banking/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-future-of-open-banking/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-future-of-open-banking/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-future-of-open-banking/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-future-of-open-banking/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-future-of-open-banking/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-future-of-open-banking/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-future-of-open-banking/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-future-of-open-banking/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-future-of-open-banking/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-future-of-open-banking/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-future-of-open-banking/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-future-of-open-banking/joint-statement-by-hm-treasury-the-cma-the-fca-and-the-psr-to-update-on-the-fca-and-the-psr-to-update-on-the-fca-and-the-psr-to-update-on-the-fca-and-the-psr-to-update-on-the-fca-and-the-psr-to-update-on-the-fca-and-the-psr-to-update-on-the-fca-and-the-psr-to-update-on-the-fca-and-the-psr-to-update-on-the-fca-and-the-psr-to-update-on-the-fca-and-the-psr-to-update-on-the-fca-and-the-psr-to-update-on-the-fca-and-the-psr-to-update-on-the-fca-and-the-psr-to-update-on-the-psr-to-update-on-the-psr-to-update-on-the-psr-to-update-on-the-psr-to-update-on-the-psr-to-update-on-the-psr-to-update-on-the-psr-to-update-on-the-psr-to-update-on-the-psr-to-update-on-the-psr-to-update-on-the-psr-to-update-on-the-psr-to-u$ 

<sup>10</sup> https://bills.parliament.uk/bills/3430

JROC published its recommendations for the next phase of Open Banking on 17 April 2023. <sup>11</sup> The Treasury has committed to using the Smart Data powers, under Part 3 of the DPDI (No.2) Bill, to provide Open Banking with a sustainable regulatory framework. <sup>12</sup>

Those schemes that have developed to date have required a combination of government mandate and industry collaboration, and a well-resourced process to coordinate diverse stakeholders, agree and establish technical standards and monitor compliance. BEIS' "Regulatory Powers for Smart Data Impact Assessment" (2022) notes that "current market incentives and powers are insufficient to deliver Smart Data alone" and acknowledges "the lack of incentives for data holders to share data with TPPs [ATPs]". A "wicked problem" is that there may be a wariness of mandating open data schemes in the absence of strong evidence that the benefits of such intervention will exceed the costs (and that the schemes will not quickly be made obsolete by market and technological developments), but without the realistic prospect of such mandates arising and precisely what form these might take, there is little incentive for individuals or organisations with relevant capabilities to generate such evidence.

11 https://www.gov.uk/government/publications/recommendations-for-the-next-phase-of-open-banking-in-the-uk

<sup>12</sup> https://www.gov.uk/government/speeches/economic-secretary-to-the-treasury-speech.

<sup>13</sup> Wicked problem (wikipedia.org): a problem that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognize.

## 4. How are challenge prizes situated within the innovation landscape?

#### 4.1 Innovation funding instruments

Various funding instruments have been and are deployed to stimulate innovation, by governments and other funders. Greater detail about these instruments can be found in the innovation funding toolkits created by <a href="Challenge Works">Challenge Works</a>, <a href="Nesta">Nesta</a> and <a href="McKinsey & Co">McKinsey & Co</a>. Key instruments include the following:

#### **4.1.1 Grants**

- **Innovation grants** The most established and widely used form of innovation funding, grants can fund efforts towards reaching specific outputs but are sometimes criticised as leading to dependency rather than sustainable initiatives.
- Stage-gated grants Where a smaller grant is awarded initially followed by a 'stage-gate', and successful innovations can access larger amounts of funding once they have passed the stage-gate. Stage gates offer the funder a way to manage risk.

#### 4.1.2 Risk and debt capital

- **Impact investing** Investment that has a goal of generating specific social or environmental outcomes as well as delivering financial return (where the emphasis on each of these can vary depending on the fund).
- Innovation loans Innovate UK runs an innovation loans programme but in general loans tend to be
  less common for financing innovation than grants due to the high level of risk associated with
  innovative ventures and therefore the uncertainty about repayment.

#### 4.1.3 Outcome-based funding

- **Contract/fee** Where funders contracts for the provision of an existing good or service directly from a known and established supplier (e.g. developer of an early stage, innovative product) on behalf of beneficiaries.
- Challenge Prizes Also known as innovation inducement prizes, these are competitions that offer a financial reward to whoever can first or most effectively meet a defined challenge. In real world applications of the model, challenge prizes may also provide financial and in-kind support to participants to support them in developing their solutions (hybrid prize/grant), as discussed in Section 4.
- SBRI (Small Business Research Initiative) An Innovate UK initiative for public procurement of R&D that directs the development of solutions toward specific government needs. Unlike challenge prizes, the main incentive for innovators is the potential for procurement and adoption of the end solutions rather than a cash prize. SBRI programmes are usually structured as stage-gated grant processes.

Each of these has various benefits in terms of the stage of innovation targeted, openness to different innovators, and ultimately the reach and impact of the final solutions. This review focuses on the opportunities for challenge prizes as a vehicle for innovation funding, the relative merits of which will be discussed herein. Due to the flexibility that prizes offer in relation to other innovation policy instruments, there are a large number of different prize characteristics and thus a vast number of prize typologies based on these characteristics (Gök et al.).

#### 4.2 History of challenge prizes

Challenge prizes are one of the oldest types of innovation policy mechanisms, with one of the earliest examples being the Longitude Prize established by the UK government in 1714 to make sea travel safer. £20,000 was offered to whoever could produce a practical method of determining longitude within 30 miles at sea, and was won by a clockmaker from Yorkshire who produced the first marine chronometer.

While prizes experienced a decline in popularity during the 19th century, recent decades have seen a revival in their usage (Khan et al., Deloitte). In 2009 McKinsey & Co tracked 219 current prizes with award values of more than \$100,000, and found that the total value of that group increased more than 15-fold between 1970 and 2009. The use of prizes grew in particular in the US, with the US government creating policies for federal agencies such as NASA to use prizes as policy instruments (Burstein et al). Deloitte analysed the 314 challenges found on Challenge.gov between 2010-2014 and reported a total public spend of \$64 million in that timeframe, with a median challenge purse of \$9,500 (the maximum being \$15 million).

Besides the public sector, non-government entities have also contributed significantly to the growth in prizes in the US, most prominently the X Prize Foundation with its series of large technology-focussed prizes, as well as smaller practitioners like Kaggle. Indeed, the private sector spend on challenge prizes in the US may be much larger than that of the public sector. Brennan et al. analysed the data on challenges from McKinsey & Co, Love and InnoCentive (now Wazoku), and found \$173 million spent on prizes from the private sector (37 prizes), compared to \$60 M spent over 28 prizes for public sector institutions like DARPA and NASA.

These trends of increased prize spending have played out elsewhere, including Canada (Impact Canada) and Europe, where the European Commission has put up tens of millions of euros in prizes to address problems ranging from cleaner diesel engines to cheaper space launchers as part of its Horizon 2020 programme (European Commission). In the UK, the Centre for Challenge Prizes (now Challenge Works) was set up by Nesta in 2012 to revive the use of prizes in the UK and has designed and delivered prizes with various national and international partners including UK government departments, regulators, international NGOs and corporate foundations. There is no published data on total UK government spending on challenge prizes, with challenge prizes not identified separately as a project type in the data on Innovate UK projects (UKRI).

#### 4.3 Methodology of challenge prizes

Prizes are an instrument of innovation policy that aims to overcome market failure, for example through creating an incentive for the development of a particular technology or technology application to address some defined problem. A detailed description of the process of running a challenge prize is described in *Challenge Prizes: A Practice Guide* (Challenge Works), and follows three stages of:

- 1) Discover & Define: This phase involves carrying out research to understand the nature of the problem, and identify the most appropriate opportunities where a prize would help to stimulate innovation. This involves engaging with a broad range of stakeholders to understand the problem and seek their different perspectives on defining prize opportunities.
- 2) Design: Building on the research findings, the design prize phase is an opportunity to shape the structure of a prize and gain feedback from stakeholders (including prospective innovators) on whether the incentives, selection criteria, timelines and other elements of the prize prototype are both attractive and feasible.
- 3) **Deliver**: In this phase innovators are invited through an open call to develop solutions to a problem that has been identified as lacking existing solutions. The best ideas are selected to take part in a competition (which may be stage-gated), leading to a final cash prize for the solution that best meets the pre-defined criteria.

#### 5. In what circumstances are prizes effective and why?

Innovation inducement prizes have a wide range of rationales and there is no dominant argument which has been agreed in the literature for where their role is most appropriate (<u>Gök et al.</u>). Different hypotheses for challenge prize effectiveness are discussed in the literature (<u>Williams et al.</u>, <u>National Research Council</u>, <u>National Academy of Engineering</u>) based on ex-ante assessment, while there are limited examples of rigorous ex-post evaluations based on real evidence, as discussed in Section 3. Both types of sources are discussed in this section.

It has been noted by academic researchers that the available ex-post evidence of an academic standard on the impact and effectiveness of prizes is limited (<u>Burnstein et al.</u>, <u>Campbell</u>, <u>Gök et al.</u>, <u>National Research Council</u>, <u>Stauffer</u>). The National Science Foundation commented in 2006 that "owing to the limited experience with innovation prizes, relatively little is known about how they work in practice or how effective they may be as compared with, for example, R&D grants and contracts, or tax incentives" (<u>National Research Council</u>). Ten years later in 2016, <u>Burnstein et al.</u> reported that "modern innovation prizes, as typically implemented, are a scholarly mystery. Three literatures speak to such prizes — economic, policy, and empirical — and yet none adequately justifies the use of innovation prizes in practice, explains when they should be chosen over other mechanisms, or explains whether or why they work. As a result, prizes remain little understood as an empirical matter and poorly justified as a theoretical matter."

Similarly, a recent review by <u>Kudymowa et al.</u> found little quantitative empirical evidence on the effect of prizes on innovation, which they suggested was due to two factors. First, there is a substantial divergence between economic theory and actual prizes as these are implemented in practice, which means that there is little relevant theory for empirical research to test. Second, it is difficult to undertake a counterfactual analysis, and there is a reliance on historical case studies which can be misleading due to the very different economic and public funding contexts in which different prizes were run. Finally, funders may have limited appetite to dedicate resources to funding control groups to enable rigorous evaluation, and may also be wary of ethical or reputational pitfalls involved.

These evidence limitations should, we believe, be considered in the context of similar limitations that apply to other types of innovation funding methods. It is beyond the scope of this literature review to assess how the evidence for challenge prizes compares with that for other types of innovation support but we note the following:

- The literature of academic standard is smaller for challenge prizes than other methods, likely at least
  in part because challenge prizes are a much smaller part of the innovation funding landscape
  relative to e.g. R&D tax credits and innovation grant programmes, and the opportunities for
  evaluation are therefore correspondingly more limited.
- While there is likely a larger volume of evidence for some other methods, there remains a notable lack of rigorous evidence (including for example rigorous counterfactual evidence) for the impact of e.g. innovation grant programmes.
- Rigorous evidence based on counterfactual analysis is also notably lacking on the impact of public funding for basic scientific research in universities, but there is a strong consensus based largely on theoretical grounds that such funding is welfare-enhancing.
- Remarkably, we are not aware of any rigorous direct comparison in an experimental setting of, for example, a challenge prize and a grant programme in the academic literature.

While rigorous empirical evidence for challenge prizes in the academic literature is limited, challenge prizes consist of several components that do have evidence. For example, the principle that people respond to financial incentives is widely accepted in the economic literature, as stated in Prof. Gregory Mankiw's Principles of Economics "Principle 4: People respond to incentives"

(<u>Mankiw</u>). Secondly, there is evidence that seed funding is an effective method to encourage the pursuit and establishment of larger, more intensive projects and grants (<u>Bhatia et al.</u>, <u>Douglas and Hartley</u>). Thirdly, there is evidence that innovators require and benefit from non-financial support alongside financial incentives (<u>Large and Muegge</u>, <u>Riepe and Uhl</u>). It is reasonable to infer that these elements will be effective within the context of a challenge prize as well.

There is a published "<u>impact evaluation</u>" of Nationwide's Open Banking for Good (OB4G) initiative, funded by Nationwide, and this is referenced here as an example of a challenge-prize-adjacent initiative related to a Smart Data scheme (UK Open Banking). This evaluation considered "the impact of OB4G from the perspective of the five Challengers that completed the programme" and "Evaluating User Impacts". This evaluation identified various qualitative benefits from the initiative for the participating "Challengers". The evaluation of "user impact" was limited by the fact that "none of the Challengers was at the stage of scaling or deploying their product at the time of the OB4G programme, [and therefore the evaluators] were not able to fully assess the impact of their products and services on end beneficiaries".

#### 5.1 Prizes in relation to intellectual property

Much of the theoretical case for challenge prizes is discussed in the context of comparing this approach to the use of intellectual property (IP) such as patents. (Roin et al, Kapczynski et al., Kremer & Williams, Brunt et al.) Intellectual property has long been used by governments as a way to stimulate innovation but it has the disadvantage of being at least partially offset by the deadweight loss created by resulting market inefficiency, which prizes aim to overcome (Gök et al.).

Clancy et al., building on the seminal 1983 paper by Wright et al., argue that prizes can lead to excessive aggregate investment due to the "common pool effect" of attracting multiple innovators to tackle a problem, in situations where the prize is split between the successful innovators. In addition, the authors argue that prizes may neglect the profit opportunities that arise through competitive advantage with the innovation process, and that deadweight losses may be unavoidable in these situations. Patents, on the other hand, may not offer sufficient incentive in some cases, for example if the cost of innovation exceeds the expected profit earned by the patent holder from the innovation (Clancy et al.).

It should be noted that much of this debate is based on a theoretical form of challenge prizes which are publicly procured and where the government determines the prize payouts for inventions after their development, based on an estimate of each invention's social value, which is delivered in place of the protection offered by patents. In practice, however, prizes are in modern times deployed alongside patents as a complementary tool, with innovators typically retaining IP on their ideas (Kremer & Williams). Indeed, prizes can encourage competition and boost innovation, as demonstrated by Brunt et al. through observing the impact on patents. The authors review nearly 2,000 prizes awarded by the Royal Agricultural Society of England (RASE) over the period 1839–1939. Those who won the prizes were much more likely to receive and renew patents, and a doubling of the prize purse led to over 33% increase in patented innovations. Even those who lost the contests cumulatively received more than 13,000 patents (Hendrix).

Some attempts to answer this question empirically have been made in addition to the theoretical models. Brueggemann et al. analysed the effects of two different innovation prizes on subjects' innovativeness via a task created to simulate the prize process. The authors found that their simulated prize conditions reduced the willingness to cooperate between subjects compared to a benchmark condition without an innovation contest, concluding that state-subsidised innovation prizes offer little benefit in addition to the existing intellectual property rights. It should be noted, however, that the authors identified a "trade-off between simulating the complex interactions of creative and dynamic sequential innovation processes accurately and keeping the task manageable for participants," suggesting that the validity of the findings may have been compromised by this proxy approach. The authors also stress that competitions can even reduce

willingness to cooperate, but not the actual level of cooperativity in practice, and the study also does not discuss the role of prize competitions in recruiting and accessing innovators in the first place.

Elsewhere, <u>Davis et al.</u> analysed the data on a number of historic prizes and found that prizes actually lead to less duplication compared to patents, attributing this to the fact that collaboration in prizes is more common and prizes can be more effectively designed to minimise duplication. The authors do warn that the prizes that do not allow patenting of the innovation might limit the further development of innovation by decreasing subsequent incentives.

The general consensus that researchers have reached in this space is that innovation inducement prizes are not a substitute for other innovation policy measures but are complementary under certain conditions (<u>Kay</u>, <u>Wilson et al.</u>). As noted by <u>Kremer & Williams</u> and <u>Williams et al.</u>, the main policy and academic debate has since moved on to focus on issues around the effective design and implementation of a prize structure, which are discussed here.

#### 5.2 Conditions where challenge prizes are/are not suitable

Much has been written in both the academic and grey literature regarding the benefits of prizes (Di Bella et al., Everett et al., Nesta, Williams et al.). Recommendations about the specific conditions in which prizes are effective have largely been developed by practitioners, as encapsulated in the Challenge Works 'Green Light Criteria' (and adapted version by Impact Canada), which were developed to assess whether a topic is suitable for a prize (Challenge Works). These Green Light Criteria are that:

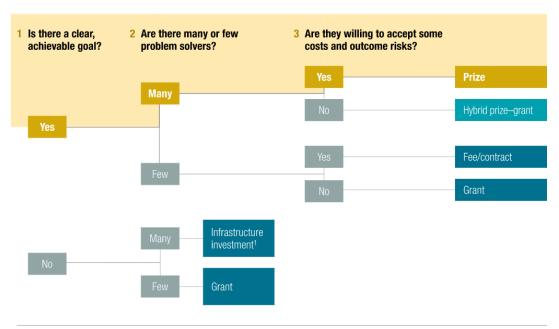
- 1) The problem is well-defined and there is a clear goal for innovators to work towards;
- 2) The best solutions will be generated by opening up the problem to a wider pool of innovators;
- 3) Solutions will be adopted or taken to market;
- 4) A prize will accelerate progress;
- 5) A prize could provide the incentives needed to motivate innovators.

Not every problem is suitable for a challenge prize, however, and it is important for funders to consider potential alternative funding instruments, including those summarised in Section 3, according to the characteristics of the problem. McKinsey & Co summarise three proposed questions that should be addressed by funders to help them determine the most appropriate funding model, as demonstrated in Figure 1. These questions are:

- 1) What is the nature of the change sought?
- 2) How many problem solvers might commit themselves to the effort?
- 3) What is their willingness or ability to absorb the risk of the effort?

Figure 1: Flow diagram demonstrating the conditions under which prizes are effective relative to other innovation funding instruments, as proposed by McKinsey & Co

Selecting the right philanthropic intrument



<sup>&</sup>lt;sup>1</sup>For example, a foundation could invest in strengthening a research institution (by endowing chairs or building facilities) or in building capacity at nonprofits or other service-delivery organizations.

The wider literature regarding the conditions under which a challenge prize is likely to be a suitable mechanism, structured using the five Challenge Works 'Green Light Criteria' (<a href="Challenge Works">Challenge Works</a>), are summarised below.

#### 5.2.1 Problems that are well defined with a clear goal

Prizes work best when there is a clear, achievable and measurable goal. One example cited by McKinsey & Co is the \$1 million Netflix Prize, which challenged data mining programmers to improve the company's online movie recommendation algorithm by 10%. Partly by releasing proprietary data of interest to data miners, Netflix was able to attract more than 34,000 entrants who were able to work towards this target. The need for a clear goal means that prizes are potentially most appropriate for applied research, prototyping, and stretch innovation goals (Gök et al., National Academy of Engineering). With applied research in particular, prizes are able to overcome some of the issues associated with grant funding. As Kremer et al. note, "researchers funded on the basis of an outsider's assessment of potential rather than actual product delivery have incentives to exaggerate the prospects that their approach will succeed, and once they are funded, may even have incentives to divert resources away from the search for the desired product."

By contrast, challenge prizes are also not suitable for funding basic research, as the defined nature of a prize does not allow room for serendipitous scientific discoveries (<u>Kalil</u>, <u>National Research</u> <u>Council</u>). In this case, where the goal is not always set from the beginning, a grant programme may be more suitable in meeting the desired outcomes. As Tim Harford of the Financial Times points out, "Even a \$100 zillion prize wouldn't buy you the next Internet—it's just too disruptive a concept." (<u>Kamenetz</u>).

#### 5.2.2 Solutions require a wider pool of innovators

Prizes are effective when it is unknown who might best solve a problem. A core benefit of

prizes derives from their ability to attract diverse talent, generate unexpected approaches, and reveal unusual perspectives in the face of a problem or challenge (McKinsey & Co). Experts and practitioners at the above mentioned 2019 workshop remarked on "the ability of prize competitions to include more diverse "solvers" when compared to other funding mechanisms—as prize participants don't necessarily need a specific technical skill or knowledge expertise to contribute to the innovation process, which in turn, helps build a larger community of practice." (National Academy of Sciences). Evidence of this ability of prizes to bring in the 'unusual suspects' is demonstrated in a report of the 2004 and 2005 DARPA Grand Challenge prizes, which found that media coverage of these prizes led to it attracting innovators who had not previously worked with DARPA (DARPA Prize Authority). Another example of this is the Orteig Prize, a \$25,000 prize announced in 1919 for the first nonstop flight between New York and Paris. Conventional wisdom of the day was that such a transatlantic flight would require a heavy, multi engine plane with a large crew, but the goal was instead achieved in a single engine plane with one pilot (Schroeder).

Prizes can work well in situations that benefit from cross-sectoral collaboration. Although it may appear counter intuitive, prize participation can also incentivise collaboration between innovators and researchers working in adjacent fields. One of the leading early ideas for economic recovery from COVID-19 was the implementation of low cost, rapid antigen testing deployed at scale, which required innovation across a number of domains including biology, chemistry, material science, medicine, manufacturing, data management, and logistics. A £1 billion prize was proposed to incentivize universities to collaborate towards a solution with a capacity to test 10 million people per day, on the basis that traditional incentives such as research grants were insufficient to compel university researchers to work together on more effective testing methods (Grove).

Sigurdson demonstrated the effect of challenge prizes on collaboration empirically based on data from the 2005 DARPA Grand Challenge through a difference-in-differences estimation strategy, in which the size of the unique annual coauthor pool of prize participants (treated) was compared with that of non-participants (non-treated) both before and after the announcement of the prize. Results indicated that the prize reduced the costs of future collaboration by incentivizing researchers to learn how to work on complex real-world problems requiring multiple domains of expertise. Increases in collaboration occurred both on the extensive margin (more unique coauthors) and intensive margin (more papers with existing coauthors), and also persisted for years after the prize.

#### 5.2.3 Innovators see a prize as a significant incentive

Prizes work best when there is a pool of innovators who are able and willing to bear some of the costs and risks. One of the perceived benefits of challenge prizes is that they shift the risk from funders to innovators, attracting investment of their time and capital. One example of this is the Ansari X PRIZE to develop spacecraft capable of entering space and returning safely twice within ten days, in which competing teams spent more than \$100 million in pursuit of the \$10 million award. Similarly, innovators taking part in the NASA Centennial Challenge to develop lunar landers, regolith excavators, and astronaut gloves committed their own time and assets to pursue prizes whose value typically represents "about one-third of the amount [that] it takes to win" (McKinsey & Co). In addition to the investment of time and capital from innovators, challenge prizes can be effective at leveraging further investment from external sources after some initial success has been demonstrated (Di Bella et al., Kumar, Impact Canada).

Since prizes provide the reward only after the target outcome is reached, prizes might not always give sufficient inducement if the innovators in question cannot afford to develop the technology in the first instance (<u>Gök et al.</u>). As <u>McKinsey & Co</u> describe, this will depend on how much money and time problem-solvers can afford to commit, their weighing of those costs versus the potential reward, and their view of the likelihood of success. For example, most researchers and small and medium-sized companies find it difficult to self-finance or raise external funding (<u>Kalil</u>). For this reason, prizes are often combined with grants (as well as other non-financial support and

incentives) in a hybrid structure to provide innovators with the incremental support that they need to succeed.

#### 5.2.4 There is a path to financial sustainability for the successful teams

Challenge prizes work best if there is a viable route to market for solutions generated. If designed well, challenge prizes can leverage substantial amounts of private capital in addition to the investment made by innovators themselves, with figures pointing to 2-50 times the amount of private capital relative to the cash rewards. (Kudymowa et al.) Solutions will of course need to demonstrate commercial viability in order to raise this external investment. Indeed, a definition shared by the former UK's Department for International Development (DfID), Inter-American Development Bank (IADB) and the Canadian International Development Agency (CIDA) describes challenge prizes as 'a competitive mechanism to allocate financial support to innovative projects... with the potential for commercial viability' (Pompa).

#### 5.2.5 A prize will accelerate progress

Challenge prizes work well in the early stages of developing a market. This is important to avoid funding work that would happen anyway, for example driven by existing market demands. As argued by Zorina Khan from Bowdoin College in a 2019 workshop on challenge prizes, "prizes are most effective when used to incentivize activities that are not market-driven." (National Academies of Sciences). Empirical studies by Kay on the 2004 Ansari X Prize suggested that this \$10 million prize spurred \$20 million total investment, concluding that the prize "triggered new R&D activity in a narrowly defined technology sector with no active developments". While assessing additionality is very difficult, the author suggests that additional and accelerated innovation can be created in the presence of open-ended rules, technology gaps to win the competition, and significant technology incentives.

Challenge prizes are effective for problems that lack attention. By generating excitement, public engagement and bringing different stakeholders together, challenge prizes can shine a spotlight on problems where there was previously limited innovation and/or market traction. In their evaluation of the Progressive Automotive Insurance X PRIZE (PAIXP), Murray et al. established that rewards such as "publicity, attention, credibility, access to funds and testing facilities, community building" can be reached by non-winning participants as well as winners which a justify the resources they invest, demonstrating the much wider benefits of awareness raising that prizes offer in addition to generating a solution to the challenge." Others have reported that the generation of 'spill-overs' by prizes can be an effective sources of reputation for sponsors and entrants, creating communities and networks which operate beyond a particular prize (Davis et al., Kay). Indeed, a successful prize will generate spillover benefits in publicity and prestige that overwhelm the value of the prize itself (Hendrix).

### 6. What design variables are used to drive outcomes from prizes?

Challenge prizes are broad and diverse, both in terms of the forms that they take and what they are used for. There are a large number of different prize characteristics and thus a vast number of prize typologies based on these characteristics (Edler et al.). For this reason, it is important for prize practitioners to dedicate time and attention to ensuring that the design features of any given prize are appropriate for the problem and solution space in question. It is important to state upfront that this includes much more than the size of the financial reward: as stated by Professor Hayagreeva Rao of Stanford's Graduate School of Business, "an ineffective prize is simply giving people money without devoting any thought to [the] other symbolic and psychological elements of prize architecture." A risk for prize sponsors is to focus exclusively on the size of the award rather than other dimensions that can contribute to the effectiveness of the prize. A prize's goals, strategy, delivery and learning model are all critical to its impact (McKinsey & Co).

#### 6.1 Design variables used in practice

#### 6.1.1 Size of financial reward

Unlike a grant programme, the size of the financial reward that teams are offered with a challenge prize is a reward intended to generate excitement and interest and stimulate activity, rather than being a payment to cover the costs of implementing their innovation (Brown et al.). However, the monetary value of the prize is of course an important variable in determining outcomes. Boudreau et al. found from their empirical analysis of software competitions that cash incentives increased the effort and performance of especially higher skilled participants. But compared to conventional measures such as grants which are based on actual cost of research, estimating the monetary value for a prize before solutions are developed is very difficult. If the prize is too low, it will not attract enough attention from potential entrants. If the prize amount is set too high, there may be inefficiencies both in terms of the money spent by the prize organiser, as well as leading to an above optimal amount of research being conducted by participants who are attracted by high prize (Gök et al.).

#### 6.1.2 Level of ambition of the challenge

It is important to define the challenge, and criteria for its achievement, to be neither too easy nor too difficult to achieve. In Richard Feynman's lecture on nanotechnology, he offered to pay one thousand dollars to anyone who could build an operating electric motor that would be no larger than one-sixty-fourth of a cubic inch. The next year, an engineer figured out how to do it using conventional tools. He met the conditions of the prize, but failed to advance the science of nanotechnology that Feynman had hoped for (Kalil). On the other hand, making the criteria too difficult can result in targets that are never achieved. The Rockefeller Foundation established a one million dollar prize for a low-cost way to test for gonorrhoea or chlamydia in 2005. The criteria were that the test would be 99 percent accurate, cost less than twenty-five cents per usage, use non-invasive samples, and provide immediate and reliable results that could be interpreted by health workers with a primary education and no more than two hours of training. The Rockefeller Prize was never claimed (Kalil).

#### 6.1.3 Number of prize participants

The number of innovators invited to participate in the prize has an important impact on the solutions developed, both in terms of individual motivations and overall probabilities. Using a unique data set of software related challenge prizes, <u>Boudreau et al.</u> provide evidence of two

coexisting and opposing forces that operate when the number of prize participants (competitors) was increased. On one hand, greater rivalry led to negative incentive effects, reducing the incentives of all competitors in a contest to exert effort and make investments. On the other hand, adding more competitors increased the likelihood that at least one competitor would find a solution that met the criteria. The authors found that the effort-reducing effect of greater rivalry dominates for less uncertain problems, whereas the effect on the extreme value prevails for more uncertain problems. Adding competitors thus systematically increases overall contest performance for high-uncertainty problems.

#### 6.1.4 Provision and types of non-financial benefits

In addition to the final financial reward, challenge prizes can be designed to offer a number of different non-financial benefits including privileged access to datasets or data sandboxes, contact with regulators and other stakeholders, publicity, and accelerator-style capacity development. In many cases, practitioners find that these non-financial benefits are of equal or greater incentive than the financial reward (Challenge Works). Indeed, Kay analysed the qualitative evidence around the X Prize, Ansari X Prize, Northrop Grumman Lunar Lander Challenge, and found that nonmonetary incentives and potential market value of technologies were a more important incentive than the monetary prize itself. Similarly, under the Ideas to Impact challenge prize programme created by DFID in 2013, it was found that "solver support may be both necessary to achieve the prizes' intended outcomes and beneficial to solvers as a non-financial incentive." (Brown et al.)A notable example of the value-add that non-financial benefits can offer is based on the evaluation reporting of the Open Up 2020 Open Banking challenge run by Challenge Works (Nesta Challenges). Finalists in this prize received a £50,000 grant as well as non-financial support over a 10 month period to accelerate their growth, including marketing strategy, service design, growth strategy, media training and user testing. Most importantly, they were also given to a highly secure sandboxed dataset of millions of customer bank transactions in order to safely test their solutions. Out of the 15 finalist teams, 14 agreed that the challenge improved the capabilities of their team and 12 agreed that they were able to access support that they would not otherwise have been able to. The challenge also helped the innovators create new partnerships and collaborations. Miles Cheetham, judge for the Open Up prize and programme manager for OBIE, stated in this report that "the non-financial support and access to OBIE gave the teams a chance to ask questions, put their own business under the lens and emerge with a better network, fresh ideas and greater skills."

#### 6.1.5 Structure of reward

Different approaches can be taken to structuring the financial reward, including the number of winners it is divided between. Zivin et al. studied the impact of this variable on innovation outputs experimentally by running an innovation competition with the life sciences company Thermo Fisher Scientific, in which participants were asked to design solutions to help share medical equipment across small providers in Mexico. The participating innovators were randomised into two distinct compensation schemes: one which was winner-takes-all, and another in which the ten best proposals received some form of compensation (with the same total payout as the other arm). The former provided participants with high-powered incentives to innovate but no insurance for inferior solutions, whereas the latter provided some insurance for participants that their efforts could be rewarded even if their proposals were not quite best-in-class. The authors found that a winner-takes-all compensation scheme generated proposals that were significantly more novel relative to the distributed compensation scheme, concluding that the risk taking encouraged by the competition with a single prize had driven innovators to pursue more creative solutions.

Another design variable in the reward structure is whether winners are selected on a first-to-call (whomever meets the goal first wins the prize) or best-by-deadline (all solutions are evaluated together after a pre-defined deadline, and the solution that best meets the selection criteria wins the prize) basis. In practice, there are relatively few examples of first-to-call prizes, with the Ansari

X Prize being a notable example (<u>Nesta Challenges</u>). While little is known about which of these approaches is most effective, the lack of first-to-call approaches may in part be due to the programmatic challenges of being unable to accurately predict programme costs for a prize with an undefined timescale.

## 7. What practical implications can be drawn from the challenge prize literature for a possible Smart Data challenge prize?

This report synthesises the literature relating to the deployment of challenge prizes, the contexts in which they should be used, and the design variables that can be tailored to achieve the desired outcomes.

This section considers what practical implications can be drawn from the challenge prize literature for a possible Smart Data challenge prize. The kinds of practical implications we might like to draw out are:

- 1) Whether a challenge prize is likely to be a good model for achieving specified goals in relation to Smart Data; and
- 2) If so, what form should the challenge prize take?

There are significant difficulties in drawing such implications from the literature, namely that:

- There is very little challenge prize literature geared towards providing specific, tailored insight to a
  Smart Data challenge prize, or to those making design decisions about a Smart Data challenge
  prize. This reflects the very small number of organisations with practical experience of designing and
  delivering challenge prizes, the limited incentives these organisations have to publish such practical
  quidance and the unique, emergent nature of Smart Data-oriented considerations.
- Extrapolating from general principles about circumstances in which challenge prize are likely to prove effective and about challenge prize design principles to a unique, specific set of circumstances is not straightforward, and is typically a task for the Discover & Define phase of a challenge prize as described in Section 4. While the literature offers general principles, it generally does not offer guidance as to how these should apply in specific circumstances. This is a general truth about the difficulty in translating from general principles to specific circumstances, but the nature and extent of that difficulty is context-specific. In the case of challenge prize design generally, and of a possible Smart Data challenge prize specifically, these difficulties are substantial.

## 7.1 Is a challenge prize likely to be an effective model for achieving its intended goals?

As discussed in Section 5, Challenge Works' 'Green Light Criteria' (<u>Challenge Works</u>) provide the most systematic practitioner-focussed guide to determining whether a prize is likely to be an appropriate method in a given context, although these remain high level in nature (necessarily, as they aim to apply in all possible situations in which a prize is being considered). We consider how these Green Light Criteria might apply in the case of a possible Smart Data challenge prize.

#### The problem is well defined and there is a clear goal for innovators to work towards.

A key question to be considered in the design of a potential Smart Data challenge prize is: what is the goal that such a prize would set for participating innovators? If a clear, readily measurable goal cannot be defined for participating innovators, it is important to define other ways in which clarity can be provided to them on what success looks like for the purpose of the prize (e.g. through clear, straightforward assessment criteria).

The best solutions will be generated by opening up the problem to a wider pool of innovators.

In the case of a Smart Data challenge prize, attempting to apply this principle raises the question of what is meant by the "best solutions". If we assume these are the solutions that in some sense make the most creative use of cross-sector Smart Data for the benefit of consumers, it seems intuitive that opening this up to a wide pool of innovators would be beneficial.

#### Solutions will be adopted or taken to market.

Applying this criterion to the specific circumstances in which a Smart Data challenge prize aiming to "identify a range of new detailed cross-sector use cases for Smart Data" (per DBT's specification) would take place is difficult., This is because (i) whether solutions developed in a Smart Data challenge prize can be taken to market will depend on the evolution of Smart Data policy (e.g. which Smart Data schemes, if any, will be implemented, on what timescale, and how) and (ii) there is uncertainty about the future evolution of Smart Data policy.

As noted earlier, there is at present only one live Smart Data scheme, [O]pen [B]anking, covering a specific set of products in the retail financial services sector. Almost by definition, cross-sector Smart Data use cases can only come to market if there are Smart Data schemes covering more than one sector. These schemes might result from regulatory action (like [O]pen [B]anking), or – in principle at least – they might be private schemes. It is not within the scope of this work to consider whether and how private Smart Data schemes may come forward in the absence of regulatory action.<sup>14</sup>

The key implication in relation to a prize is that, for it to be successful in encouraging innovators to develop cross-sector Smart Data use cases, it will be important that they have confidence that there are prospects for bringing use cases that they develop to market. This does not, in our judgement, necessarily mean that new schemes (beyond Open Banking) need to be in place at the time the prize happens in order for a prize to be successful. But the more clarity that can be provided by government about the future path for Smart Data policy, the more confidence innovators will have about market opportunities and therefore the more interest they will have in aligning their activity to government's objectives for the prize.

#### A prize will accelerate progress.

This is also a difficult criterion to apply to the specific circumstances in which a Smart Data challenge prize would take place, as it is contingent on the evolution of the wider Smart Data environment. For example, a challenge prize is more likely to "accelerate progress" in the sense of accelerating the development of commercially sustainable cross-sector smart data use cases if new Smart Data schemes are either implemented or committed to be implemented, thereby removing a major element of uncertainty from innovators' decision-making.

#### A prize could provide the incentives needed to motivate innovators.

A key question for the design of a possible Smart Data challenge prize is what incentives the prize offers to participating innovators. Much of the (theoretical and empirical) academic literature on challenge prizes focuses on the provision of financial incentives (owing perhaps to the tractability of financial incentives in economic modelling and quantitative empirical work). In practice, however, other incentives can be offered, and such incentives may be as or more important than potential financial incentives. In the case of a Smart Data challenge prize, such incentives for innovators might include, for instance, access to data, the ability to work directly with data holders or with regulators.

<sup>14</sup> BEIS note<sub>d</sub> in BEIS (2022) "Regulatory Powers for Smart Data Impact Assessment" that "Private sector led [Smart Data] schemes, with clear and widely adopted standards for customers to share data with third parties, have failed to materialise in key markets. This is likely due to insufficient incentives, where customers and new market entrants would benefit, but also as implementation costs would primarily fall on incumbent data holders."

Overall, the practical implication for a possible Smart Data challenge prize is that a challenge prize may (or may not) be an effective model, depending in particular on the specific outcomes pursued through the prize and what incentives a prize might be able to offer to participants. Key questions to be addressed in further research are:

- What specific kinds of outcomes would constitute success for a Smart Data challenge prize?
- What other relevant incentives may be available to offer to potential participants in a challenge, and how innovators are likely to respond to these incentives? What relationship should we expect between the kinds of incentive on offer and the kinds of outcome that can be achieved?

#### 7.2 What form should a possible Smart Data challenge prize take?

On this question it is difficult to draw robust conclusions from the existing challenge prize literature. The published academic literature has in general relatively little to offer the challenge prize practitioner seeking to make specific design decisions, and we have found nothing in the academic literature providing guidance relevant to the salient features of the circumstances in which a possible Smart Data challenge prize would take place. However, there are insights from the practitioner literature - as mentioned in Section 6 in relation to the Open Up challenge prize evaluations - that are useful to consider here, including the provision of non-financial resources as potential incentives to motivate innovators. These can include incentives such as data access, synthetic or otherwise, that help to overcome the lack of data schemes. In our view the most significant of these features for the design of a possible Smart Data challenge prize is uncertainty about the future of Smart Data schemes - which will be coming forward, when, how they will be designed, and how they will be governed. This uncertainty will serve as a countervailing force to the effectiveness of a prize, so prize design needs to investigate whether these sources of uncertainty can in any way be mitigated and what incentives can be offered that could mitigate the effects of uncertainty.

It seems likely that, given this uncertainty, moderate financial incentives alone - whether provided in the form of grants, prizes or a hybrid - may be inadequate for a challenge prize to achieve its intended objectives, though this is an empirical question for investigation with potential prize participants. McKinsey & Co highlights the hybrid prize-grant model as being appropriate in circumstances where participants are "not willing to accept some costs and outcome risks". It seems likely that such a hybrid will be more appropriate in these circumstances than a "pure play" prize model in which all financial rewards are outcome-contingent, given the extent of other contextual uncertainty in which a possible prize will take place.

#### 7.3 Addressing gaps in the literature

There remain a number of unanswered questions in the field about how prizes should be delivered and their impact. It is evident from the literature analysed that more robust evaluations are required to build out the evidence base of for the impact of innovation inducement prizes impact in different contexts, although this is also noted in the context of limited evidence around other (more prevalent) innovation funding mechanisms such as innovation grants. There are several potential reasons for this. Firstly, compared to other innovation methods, challenge prizes have only been deployed relatively recently in innovation policy in some countries and remain non-existent in the innovation policy mix elsewhere, resulting in the number of studies that look at impact being relatively low (Gök et al.). In addition, measuring impact robustly in prizes (as indeed for other innovation policy mechanisms such as innovation grants) is difficult and costly, and there remains limited research or programmatic funding dedicated to the most robust forms of evaluation work. The timescales required to measure impact can be a barrier to evaluation, and the lack of natural counterfactual in most cases (along with the ethical, cost and logistical barriers of creating artificial counterfactuals) means that it is difficult to measure genuine additionality.

Ideally, the literature would offer guidance that enabled the practitioner to determine with confidence whether, given their goals and the context, a challenge prize was an appropriate model to deploy and what form the challenge prize should take. But this is surely not a realistic goal, given that the range of important contextual factors that could be relevant to answering such questions is exceedingly large and probably not determinable in advance. The literature does not (and perhaps cannot in principle) provide a useful standardised way of categorising these contexts and matching these to different prize models. For example, for the potential Smart Data challenge prize under consideration here, the absence of currently operational or planned Smart Data schemes beyond Open Banking is, we believe, an especially significant factor to be taken account of in prize design, and a factor about which existing literature does not provide relevant evidence.

However, it is clear from both the historic and recent examples of challenge prizes in the literature, including the limited experimental evidence and post-prize evaluation work that has been carried out, that this mechanism can be an effective way to stimulate innovation to tackle diverse social challenges when deployed under the right conditions and circumstances. Namely, this involves there being a problem where a clear goal can be defined but there is a broad pool of innovators who can be attracted to the problem, and one where a prize is likely to accelerate innovation towards long-term, viable business models for the solutions. Challenge prizes can help overcome some of the inherent barriers that are observed with other funding instruments, and should be considered as a complementary tool alongside other approaches to stimulate innovation for social good.

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