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Advanced Manufacturing Supply
Chain Initiative (AMSCI): Impact
and Economic Evaluation Scoping
Study

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Contents

Contents	3
Executive Summary	7
Objectives of this Report	7
Advanced Manufacturing Supply Chain Initiative	7
Rationale for Intervention	7
Key Outcomes	8
Measurement of Outcomes	8
Impact Evaluation Options	9
Economic Evaluation Options	9
Recommended Main Stage Specification	10
Summary of Other Recommendations	11
1.0 Introduction	12
1.1 Objectives of this Report	12
1.2 Methodology	12
1.3 Structure of this report	13
2.0 Evaluation Framework	15
2.1 Objectives of Impact and Economic Evaluation	15
2.2 Aims and Objectives of AMSCI	15
2.3 Market Failure Rationale	16
2.4 Logic Chain	18
2.5 Key Outcomes	23
2.6 Wider influential factors	24
2.7 Regional Round 1 and WMLCR	25

2.8	Summary	25
3	Measurement of Outcomes	27
3.1	Mapping of Data to Key Outcomes	27
3.2	Monitoring Data	27
3.3	VML datasets.....	33
3.4	Wider Datasets	35
3.5	Prices and consumption.....	36
3.6	Value of Intellectual Property	36
3.7	Spill-over Effects.....	37
3.8	Primary Data Collection	38
3.9	Monitoring of Wider Programmes.....	39
3.10	Summary.....	40
4	Impact Evaluation Options	42
4.1	Counterfactual Definition.....	42
4.2	Selection bias and selection of counterfactual groups.....	42
4.3	Matching.....	43
4.4	Longitudinal Panel Techniques	46
4.5	Timing of Rounds.....	47
4.6	Regression Discontinuity Design	48
4.7	Displacement and Multipliers	52
4.8	Dealing with small sample sizes	54
4.9	Randomisation.....	55
4.10	Summary.....	56
5	Economic Evaluation	57
5.1	Costs	57

Programme administration costs	57
Transaction costs	58
On-going costs.....	60
5.2 Benefits.....	60
Increase in output.....	60
Value of Intellectual Property.....	62
Innovation Spill-over Effects.....	62
Environmental externalities	63
Consumer surplus	63
5.3 Benefit to cost ratios	63
5.4 Cost Effectiveness Analysis	64
6 Conclusions	65
6.1 Key Conclusions	65
6.2 Recommended Main-Stage Specification	67
Annex A: Description of AMSCI.....	71
A1 Aims and Objectives	71
A2 Resource Allocation Process	71
A3 Characteristics of Projects	73
Project objectives	73
Project spending	74
Anticipated benefits.....	75
Markets	76
A4 Participants.....	76
A5 Primes / Tier One Suppliers.....	78
Annex B: Monitoring.....	79

B1.1 Overview.....	79
B1.2 Application Data.....	80
B1.2. Appraisal and Project Selection Data.....	81
B1.2.1 Technical Appraisal Data	81
B1.2.2 VFM assessment	84
B1.2.3 Project Selection Decisions.....	85
B1.3 Monitoring Data.....	85
B1.3.1 Monitoring Indicators.....	86
B1.3.2 Monitoring Process	86
B1.3.3 Monitoring Control Sheet	87
B1.4 Summary.....	88
B2 Monitoring Data Assessment	89
B2.1 Scope of Monitoring Indicators.....	89
B2.2 Approach to monitoring.....	91
B2.3 Applicant Details	92
B2.4 Data Capture	93
B2.5 Details of Primes.....	93
B2.6 Robustness of MI.....	94
B2.7 Recommendations.....	95
Annex C: Wider Datasets	97
C1 Patent Data.....	97
C2 Meter Point Data.....	97
C3 HMRC Trade Statistics	98
Annex D: Other Government Programmes.....	100

Executive Summary

Ipsos MORI, Ecorys and George Barrett were commissioned by the Department for Business, Innovation and Skills in June 2014 to undertake the study 'Advanced Manufacturing Supply Chain Initiative: Data Monitoring, Process Evaluation, Scoping Impact and Economic Evaluation Options, and Early Additionality Assessment.' This report sets out the results of the scoping of impact and economic evaluation options for a main-stage evaluation of the Advanced Manufacturing Supply Chain Initiative.

Objectives of this Report

The overall aim of the scoping study, as specified in the Invitation to Tender, is to examine the options for a future impact evaluation of AMSCI:

- In principle, given the nature of the programme design;
- In practice, given data availability and the systems able to provide it.
- Suggestions for policy adjustments to allow for a more robust impact evaluation.

The impact evaluation will need to address questions of how far the intervention was better than doing nothing and did AMSCI successfully address the market failures it was set up to address. The economic evaluation scoping study should consider whether one of following approaches could be taken: a cost-effectiveness analysis, a return on investment study relating the value of GVA created to the costs involved, and a full cost-benefit analysis examining and valuing the full range of costs and benefits involved.

Advanced Manufacturing Supply Chain Initiative

AMSCI is a competitive fund that provides subsidies for capital investment, research and development expenditure and training for industrial projects involving collaborations across supply chains (including projects involving the re-shoring of manufacturing operations to the UK). A total of 168 applications have been received across the various AMSCI funding rounds (excluding AMSCI 2014), of which 58 were approved for funding.

Rationale for Intervention

The rationale for AMSCI is underpinned by both traditional market failures associated with imperfections in financial markets, spill-over effects associated with R&D activity, and difficulties in internalising the full benefits of training. However, AMSCI has distinctive features in supporting collaborative industrial projects, which may fail to emerge even where it is in the best interests of the parties involved to collaborate, due to problems caused by the threat of free-riding, the incompleteness of contracts, and issues caused by uneven distribution of returns. Public subsidies (as well as the requirements for monitoring) for these types of collaborative project have the potential to address these market failures and strengthen the competitiveness of firms within the supply chain of large manufacturers.

Key Outcomes

Key outcomes that an evaluation of AMSCI would ideally focus on are:

Inputs and Collaboration	Intermediate Outcomes	Impacts
<p>Inputs</p> <ul style="list-style-type: none"> • Capital expenditure • R&D expenditure • Training expenditure <p>Collaboration</p> <ul style="list-style-type: none"> • Collaboration agreements in place • Novelty of industrial collaborations • Stability of industrial collaborations • Resources committed to industrial collaborations 	<p>Capital outcomes</p> <ul style="list-style-type: none"> • Increase in capital stock • Re-shoring <p>R&D outcomes</p> <ul style="list-style-type: none"> • Technical progress • Patenting activity • Value of intellectual property • Introduction of new processes or products <p>Training outcomes</p> <ul style="list-style-type: none"> • Number of workers training • Level and type of training <p>Supply chain coordination outcomes</p> <ul style="list-style-type: none"> • Reduced supplier reliance • Improved contingency planning • Supply chain insurance coverage • Supply chain insurance premiums • Strategic visibility • System integration • Transaction cost savings 	<p>Direct productivity effects</p> <ul style="list-style-type: none"> • Increase in average labour productivity (GVA per workers) • Increase in Total Factor Productivity (TFP) <p>Other direct economic effects</p> <ul style="list-style-type: none"> • Employment • Sales • Profits • GVA • Imports as percentage of inputs consumed (Primes) <p>Displacement and multiplier effects</p> <ul style="list-style-type: none"> • Displacement (jobs, GVA) • Supply chain multiplier effects (jobs, GVA) <p>Environmental externalities</p> <ul style="list-style-type: none"> • Change in energy efficiency (CO2 emissions per unit of output) • Net change in CO2 emissions <p>R&D spill-over effects</p> <ul style="list-style-type: none"> • Profit gains to non-beneficiary firm by exploiting R&D generated by AMSCI beneficiaries <p>Consumer surplus</p> <ul style="list-style-type: none"> • Consumption • Output prices

Measurement of Outcomes

Longitudinal records of a wide range of outcomes of interest are available through data-linking to administrative datasets. These sources should be fully exploited before recourse is taken to less robust data collection methods. Secondary sources (including those held in the VML, PATSTAT, Dunn & Bradstreet credit data, and Meter Point data) will provide comprehensive records on employment, turnover, patenting activity, supply chain development, and energy consumption.

However, there will be challenges in gathering the evidence needed on capital expenditure, GVA, profits and expenditures on goods and services to estimate the productivity effects of AMSCI. Administrative data provide no records of training expenditure, measures of R&D expenditure will only be available on a longitudinal basis for known R&D performers; and it will not be feasible to estimate the net resource costs and productivity benefits of AMSCI using administrative data alone.

Monitoring processes could be enhanced to collect the financial data needed for successful applicants relatively robustly (as suggested in the Pilot Monitoring Report), and it is recommended that BIS make the necessary adjustments to simplify the potential data collection challenges associated with a main-stage study. Primary surveys of beneficiary and non-beneficiary firms may be another means of filling gaps in the evidence base, though it is anticipated that such data collection methods will prove sub-optimal. It will not be possible to collect the information needed to value R&D spill-overs or any consumer surplus benefits.

Impact Evaluation Options

Given the anticipated differences between successful and non-applicants to AMSCI, it is suggested that a counterfactual sample is drawn from the pool of available unsuccessful applications to minimise the challenges involved in addressing selection bias. There is no evaluation strategy that will design out all possible issues involved, and a hybrid strategy is suggested combining (1) fuzzy RDD methods, (2) approaches based on exploiting the differences in the timing of application rounds, and (3) general longitudinal panel methods.

Displacement is likely to be highly challenging to estimate robustly but is clearly central to developing a comprehensive understanding of the causal effects associated with the programme. The impact evaluation should explore the potential to identify a negative treatment effect amongst non-beneficiaries, as well as examine the causal effects of AMSCI on the import share of input consumption by beneficiary and non-beneficiary firms (if it is possible to access HMRC trade data). These approaches are not risk free, and if there is little confidence in the results, this will need to be addressed in the economic evaluation by focusing solely on the improvements in productive efficiency. .

Sample sizes pose a risk to the impact evaluation and BIS should consider the potential to pool AMSCI with other programmes such as APC and the ATI to maximise the numbers of observations available. Additionally, case based approaches grounded in Synthetic Control Group methods may be a useful complement to quantitative analysis.

Economic Evaluation Options

A comprehensive cost-benefit analysis of AMSCI will need to cover three forms of cost associated with the delivery of the programme:

- **Administration Costs:** incurred by BIS, Innovate UK, members of the Independent Investment Board, and Finance Birmingham in the development and administration of the scheme. This can largely be captured through existing monitoring, though additional research will be needed to estimate the value of some of the costs incurred by the public and private sector through the appraisal and project selection process.

- **Costs incurred by applicants** in the preparation of their applications, and where successful the transaction costs incurred through compliance with the obligations of the Final Grant Offer Letter. Evidence on the scale of these costs have been collected through the parallel process evaluation and can be exploited here.
- **Additional resource costs** incurred as a consequence of the subsidies provided through AMSCI (investment in capital, research and development, and training expenditure). These costs would need to be estimated through the impact evaluation.

In terms of benefits, a CBA would need to focus on establishing:

- **Net increase in output:** The impact evaluation should – in principle – provide the results required to do so (including potentially any welfare effects driven by displacement from less to more productive firms). However, there are substantial risks associated with obtaining robust measures of these externalities and if confidence in results is low, the evaluation should seek to value the improvements in productive efficiency rather than the overall GVA gains made.
- **Excluded benefits:** There will be no feasible means of valuing the effects of AMSCI in terms of R&D spill-overs, value of intangible assets, improvements in environmental efficiency, or consumer surplus.

Recommended Main Stage Specification

In terms of the key features of a main-stage evaluation of AMSCI, the following approach is recommended:

- **Data collection:** An impact and economic evaluation will be largely achievable through exploitation of secondary datasets (including the datasets held within the VML). However, it is recommended that additional longitudinal data is collected from successful applicants to fill the core gaps in data availability.
- **Timing:** The majority of AMSCI projects will complete by 2018, and allowing three years for impacts to accrue, a final evaluation study is suggested in 2021. There may also be interest in undertaking a supplementary interim impact evaluation study in 2018 (though this would unlikely give a comprehensive assessment of the impacts achieved).
- **Optional elements:** Optional elements to a main-stage evaluation could include an **updated process evaluation** (focusing largely on the performance of the projects funded through AMSCI in delivering against their contracted targets), a **separate analysis pooling AMSCI with other schemes** with similar objectives and resource allocation mechanisms (such as APC and ATI) to maximise the number of observations available for analysis (the primary objective of such an exercise would be to increase sample sizes, though it would limit the extent to which an assessment of the relative effectiveness of initiatives funded under the Industrial Strategy might be feasible), and **longitudinal qualitative case studies** combining quantitative analysis using Synthetic Control Group methods, analysis of MI and other secondary sources and depth research with applicants.

Summary of Other Recommendations

Theme	Recommendations
Monitoring (Priority: High)	<ul style="list-style-type: none"> • Given the challenges highlighted below in collecting this data through other means, it is suggested that the recommendations of the Pilot Monitoring Report are adopted as rapidly as possible to maximise the availability of longitudinal data for an impact evaluation of AMSCI for successful applicants, i.e. firm level measures of: <ul style="list-style-type: none"> - Employment - Turnover - Capital expenditure - Value of capital assets (i.e. capital stock) - R&D expenditure - Training expenditure - Profits - Wage expenditure - Expenditure on finished goods and services • Furthermore, these observations should be collected annually (possibly through the annual audit process) from a point in time pre-dating beneficiaries' involvement in the programme that is consistent across all rounds (e.g. 2010/11). For projects that have already started, this information should be gathered retrospectively. For AMSCI 2014 (and any future rounds), retrospective data should be gathered through the application process. • Such an approach would not support the collection of data on any counterfactual group of firms (and corrective action cannot be taken for applications already received). However, it would substantially contain the challenges that might be faced as part of a main-stage evaluation.
Wider programmes (Priority: Medium)	<ul style="list-style-type: none"> • BIS should seek to obtain data-sharing agreements to exploit the availability of wider monitoring information on related programmes. This data should be collected as part of a main-stage evaluation to provide a supplementary set of control variables to accommodate the contributory effects of other programmes towards the outcomes of interest.
Engagement with OGDs (Priority: Medium)	<ul style="list-style-type: none"> • It is recommended that BIS enter discussions with DECC to ensure that the appropriate data-sharing protocols can be put in place in advance of a main-stage evaluation of AMSCI. • The obstacles to gaining access to HMRC data are substantial in that any research application will need to demonstrate that the study will benefit HMRC in particular (not just the Government in general). • However, given the potential role of the trade statistics in resolving some of the most challenging issues associated with an impact evaluation of AMSCI, it is strongly recommended that BIS use its leverage to streamline access to HMRC datasets to enable the exploration of the issues identified above.

1.0 Introduction

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1.1 Objectives of this Report

The overall aim of the scoping study, as specified in the Invitation to Tender, is to examine the options for a future impact evaluation of AMSCI:

- In principle, given the nature of the programme design;
- In practice, given data availability to carry out an evaluation and the systems able to provide it.
- Suggestions for policy implementation adjustments that would allow for a more robust impact evaluation.

The impact evaluation will need to address questions of how far the intervention was better than doing nothing, what were the main impacts on the supply chains, were there any negative effects, and did AMSCI successfully address the market failures it was set up to address.

The economic evaluation scoping study should consider whether one or more of following three approaches could be taken: a cost-effectiveness analysis (relating the net impacts of the programme to the public investment involved), a return on investment study relating the value of GVA associated with each net additional job created to the costs involved, and a full cost-benefit analysis examining and valuing the full range of costs and benefits involved.

1.2 Methodology

This report has been based on a range of tasks completed by the team over the course of the study:

- **Familiarisation:** Initially the study team conducted 11 interviews with internal stakeholders who were involved in the design and delivery of the programme to gain understanding of the programme. This exercise covered key policy, appraisals, and contracting leads within BIS and TSB, alongside operations and monitoring leads within Finance Birmingham and Birmingham City Council. The interviews covered questions relating to policy design, marketing and communications, project appraisal process, project appraisals, project selection and due diligence, and the contracting, delivery and monitoring. Separate follow up interviews with monitoring officers from Finance

Birmingham focused in more depth on the processes involved in monitoring of live projects, while a series of interviews with monitoring officers from organisations running wider programmes relevant to AMSCI were undertaken to assess the opportunities of using this data in the full scale evaluation.

- **Document Review and logic model development:** The study team further refined its understanding of the underlying logic of intervention, market failures motivating public intervention, and the potential economic and social benefits anticipated through review of internal documents such as two versions of the Business Cases for AMSCI, memorandum of understanding between the involved organisations, application and appraisal forms, terms of reference for the Independent Investment Board, specifications of due diligence processes, templates for Grant Offer Letters, project management documents agreed with lead applicants, documentation describing the monitoring arrangements (including forms for quarterly returns).
- **Literature review:** Finally, a brief literature review was undertaken to support research options for the impact and economic evaluation studies. Though it was planned to be a standalone document, it was decided by at the inception meeting that the literature review would form one of five working papers.
- **Analysis of Application, Appraisal and Monitoring Information:** Analysis of monitoring information was performed on data supplied by BIS via Innovate UK's secure file-sharing system¹. Analysis of the data was employed to explore the viability of impact evaluation options and explore potential sample sizes that may be available for analysis, and highlight implications for evaluation (including scope for any sub-group analysis). The team also undertook statistical analyses of application and appraisal data to determine the influence of different appraisal metrics on the probability that applications are successful.
- **Data-linking:** The evaluation team liaised with the team at Aston University who were tasked to undertake a data linking exercise with the Office for National Statistics (ONS). While the linking of records of AMSCI beneficiaries to administrative and survey based datasets held within the VML had the potential to offer robust longitudinal records of key outcomes of interest, this component resulted in long delays from the side of VML. There was a high match rate of 95% match rate based on unique CRN, though this work is still in progress (and the report will be updated once further results are available).

1.3 Structure of this report

The remainder of this report is structured as follows:

- **Section 2 – Evaluation Framework:** This section sets out the rationale, aims and objectives of AMSCI including its development over time, and puts forward an overall

¹ There was a slight delay in project delivery as a result of the agreement of data sharing processes.

framework for their evaluation (including defining key outcomes and impacts that would need to be established).

- **Section 3 – Measurement of Key Outcomes:** This section explores the options available to establish evidence on the key outcomes of interest for the purposes of an impact evaluation.
- **Section 4 – Impact Evaluation Options:** This section gives detailed consideration to the issues that will need to be tackled in an impact evaluation, including options for creating a counterfactual and the analytical strategies that might be employed to help address key factors that may limit the quality or robustness of results.
- **Section 5 – Economic Evaluation Options:** This section explores how an evaluation might build on the results of an impact evaluation in order to provide an assessment of the resource costs and social benefits of the programme (and how these estimates might be brought together for the purposes of an economic evaluation of the programme).
- **Section 6 – Main stage Specification:** This final section sets out the key conclusions of this review and scoping study and sets out recommended options for delivering an evaluation of AMSCI.

Annexes:

- **Annex A – Description of AMSCI:** This Annex sets out a descriptive account of the initiative such as the evolution of rounds and the eligibility criteria for application.
- **Annex B – Monitoring:** This Annex describes a number of issues around collecting regular monitoring data during the life-time of the project.
- **Annex C – Wider Datasets:** This Annex outlines the range of secondary datasets that might be exploited in an evaluation of AMSCI.
- **Annex D – Other Government Programmes:** This Annex sets out the range of monitoring data associated with wider Government programmes that could be utilised in an evaluation of AMSCI.

2.0 Evaluation Framework

This section sets out an overall evaluation framework for the impact and economic evaluation of AMSCI. This section explores the range of market failures that AMSCI might be expected to address (based both on the policy objectives of the scheme overall and the objectives of the individual projects receiving funding), an outline of the causal process by which the scheme would be expected to deliver its anticipated results, the key outcomes that will require measurement through an evaluation, and wider external factors that will need to be accounted or controlled for in an evaluation.

2.1 Objectives of Impact and Economic Evaluation

The objectives of an impact and economic evaluation of AMSCI can be defined as follows (based on the broad distinction set out in the HM Treasury Magenta Book):

- **Impact evaluation:** An impact evaluation will focus on establishing the causal effects of the programme of subsidies and loans offered through AMSCI to the maximum degree of robustness feasible. This covers both direct effects on the firms benefitting, and any indirect effects on non-beneficiaries (such as spill-over effects).
- **Economic evaluation:** An economic evaluation will focus on exploring how far the resource and opportunity costs incurred in the delivery of AMSCI were justified by the benefits involved.

2.2 Aims and Objectives of AMSCI

AMSCI is a competitive fund that provides subsidies for capital investment, research and development expenditure and training for industrial projects involving collaborations across supply chains (including projects involving the re-shoring of manufacturing operations to the UK). The AMSCI has the following stated aim (set out in the 2011 Business Case):

'to increase manufacturing sector growth potential by addressing market failures to improve the competitiveness of England-based Supply Chains to globally competitive levels.'

In addition, the 2011 Business Case sets out the following objectives:

- Create more competitive supply chains that anchor high value-added work in England;
- Increase levels of purchasing from UK supply chains by Primes/Tier 1s;
- Attract new customers to existing supply chain companies and sustain or create new employment opportunities;
- Create better synergies and sustained collaborative relationships throughout targeted supply chains;
- Prime / Tier 1 involvement and grant competition targets public resource on greatest sector growth opportunities and levers in significant private investment;
- Enhanced Government reputation for promoting growth and rebalancing the economy.

No major revisions to the objectives of AMSCI were made in a reiteration of the 2014 Business Case (although the emphasis on re-shoring was increased substantially).

2.3 Market Failure Rationale

Given the policy rationale for AMSCI, justification for Government intervention will rest on how far there are market failures inhibiting investment in collaborative projects. The 2011 and 2014 Business Cases highlighted the well-established market failure issues associated with access to finance, and sub-optimal investment in skills and research and development. However, no specific market failure rationale was outlined in either of the Business Cases prepared with respect to the distinctive collaborative dimensions to the AMSCI programme.

Nevertheless, the academic literature points to a range of market failures that collaborative industrial projects may fail to be taken forward by firms, even if the expected returns on investment are sufficiently high:

- **Free-riding:** The success of collaborative projects will rely on the commitment of financial and human resources by the partners involved. However, unless the agreed terms of commitment can be rigorously monitored and contractually enforced, there will be incentives for each partner to reduce or minimise their contributions (without compromising their ability to appropriate project outputs). As a consequence, collaborative projects can be inherently unstable and may break down before project goals are realised.
- **Incomplete contracts:** The outcome of collaborative projects (particularly those involving a strong R&D component) can be highly uncertain. This uncertainty can create difficulties in agreeing an appropriate contractual framework under which the terms of the collaboration are defined (such as the terms under which ownership of IP will be shared). As such, some projects may not proceed owing to difficulties in agreeing these contractual issues.
- **Uneven distribution of returns:** There will often be one partner who brings the greatest expertise and resources to the collaboration. Often this partner also has the least to gain from the collaboration (and may be better off pursuing investment outside collaborative arrangements), so that unless partners can find some way of compensating the partner involved the collaborative project may not be viable.

These issues will be further complicated by the more typical market failures highlighted in the business case. For example, the uncertain and technical nature of many collaborative projects may make it difficult for investors to appraise the risks involved, creating reluctance to invest in or finance collaborative projects (and these issues will be more significant during periods of financial distress). If the collaborative project is likely to lead to substantial spill-over benefits to other firms (for example, if the technology involved will be easily copied), then this may also prevent the project proceeding. There may also be reluctance by firms to invest in any training that is fundamental to the collaborative project if there are fears that workers may be lost to competitors (preventing them from fully internalising the benefit of that training).

The market failures inhibiting collaborative projects are likely to lead to loss of social welfare through failure to realise gains in the productive capacity of supply chains through capital investment, R&D, and training. Faced with competition from low cost locations, these issues may encourage Primes to choose to source componentry and other inputs outside of the UK (leading to job losses and the 'hollowing out' of supply chains observed). The impact of suboptimal levels of collaborative working may also affect the overall efficiency, or resilience to disruption, across the supply chain as a whole. Poor overall co-ordination among firms within the supply chain will reduce efficiency in the following areas:

- **Strategic efficiency** – the overarching plan for a supply chain that is most appropriate and optimal for the industry and competitive environment. This could include the approach to the design of the structure of supply chain (supplier location for example), and long term investment activities. Incorrect decisions here may have long term impacts on cost if decisions do not align well with the capabilities or plans of others in the plan.
- **Tactical efficiency** – this relates to the medium term decisions that form part of production planning across the supply chain, such as size of production runs and shipping levels, inventory size, and staffing levels. Systematic differences in approach to production may create repeat delays or waste.
- **Operational efficiency** – this is the day-to-day, shop floor activity conducted by production managers that has an impact on the way production flows within links in a supply chain and across the length of the chain. Poor communication or low levels of skill in the workforce again can impact on production and supply across many firms within a chain.

As such, poor communication and weak collaboration can result in unnecessary delays in production within a supply chain; excess waste or excessive inventory (leading to reduced productivity). For example, cost may be incurred in the storage of inputs to production, intermediate goods and products, if firms hold back on investments in technologies and training that could improve stock control. Better communication and collaboration among firms may also help to mitigate risk, allowing for all to respond earlier in the event of a crisis, or simply as a result of changes in demand.

Additionally, inefficient supply chains will be at a disadvantage when compared with its competitors – failing to respond to changes in product demand or unforeseen challenges in production. For the supply chains that have applied to the AMSCI programme, further difficulties emerge with respect to resilience from high levels of mutual reliance resulting from the technical nature of the final product being manufactured. In the past, large or vertically integrated firms would be able to control production risk as all production would be under the control of a centralised management function. Where vertical dis-integration has occurred, both visibility and control of risk become the responsibility of individual firms, while the consequences of disruption continues to be shared by all. The impact of disruption can be significant; research in 2013 suggested that the average impact on share prices from disruptive events equated to a 7 percent drop in the affected firms share prices (World Economic Forum, 2013).

2.4 Logic Chain

This section describes an overarching logic chain for AMSCI. The scheme primarily provides subsidies for R&D, training and skills and capital expenditure, but also provides a framework within which projects can manage and monitor the progress of collaborative industrial projects. As such, the scheme has been set up to both deal with imperfections in financial markets that may cause sub-optimal levels of capital investment, spill-over effects causing sub-optimal levels of investment in research and development and training, as well as helping to correct for the market failures that prevent collaborative projects being taken forward.

On the assumption that AMSCI is effective in dealing with these market failures, the expectation is that subsidies will enable collaborative projects to proceed that would not have otherwise been taken forward by the firms involved. However, while the scope of spending associated with these projects is clear, it is not immediately clear what intermediate outcomes might be expected in terms of changes in spending on capital investment, R&D, and training. In particular, if AMSCI is more effective at addressing those market failures preventing collaboration, then it is entirely possible that no effect is observed on these measures (for example, if the AMSCI project displaces less effective single firm investments). Notwithstanding these issues, the intermediate results of projects might be expected to be observed amongst the firms concerned include:

- **Capital investment:** Increased fixed capital formation (in the form of new plant equipment and in some cases, property assets through the construction of new facilities). Studies of programmes of involving capital investment subsidies on single firm basis have shown that subsidies have the potential to raise capital expenditure, though these effects are less pronounced (or absent) where subsidies have reached large firms²;
- **Research and development:** Increased R&D expenditure and staffing levels, which in turn (depending on the outcome of projects) may lead to the acceleration of the development of new technologies, increase the readiness of the firms involved to manufacture new products or utilise new processes. This may also be observed in increases in patenting activity, the commercialisation of new products and processes, and the value of intellectual property held by the collaborating firms. A range of studies have explored the causal effects of R&D subsidies on firm level R&D expenditure and output (largely in the form of patents) and have found positive effects in both areas: a study examining the effectiveness of ERDF subsidies for R&D over the 2000 to 2006 period found that (for marginal grantees), €1 of R&D subsidy led to an increase of €1.49 in firm level R&D expenditure³, and a 2014 study of an Italian R&D subsidy programme⁴ found a positive impact of R&D subsidies on both post-treatment probability to register patents and number of patents registered (albeit with substantially larger effects for small companies than larger firms);

² See 'The Causal Effects of an Industrial Policy,' Criscuolo, Martin, Overman and Van Reenan, CEP Discussion Paper 1113, 2012. Available at <http://cep.lse.ac.uk/pubs/download/dp1113.pdf> (accessed October 2014).

³ See 'The Impact of TEKES Direct Support on Business R&D,' Einiö, 2013. Available at http://personal.lse.ac.uk/EINIO/Support_on_Business_RandD.pdf

⁴ 'The Impact of R&D Subsidies on Firm Innovation,' Bronzini and Paselli, Bank of Italy Discussion Paper 960, 2014. Available at http://www.bancaditalia.it/pubblicazioni/econo/temidi/td14/td960_14/en_td960/en_tema_960.pdf (accessed October 2014)

- **Training:** Increases in training expenditure might reasonably be expected to lead on to increase in the number of workers trained, and the quality (or level) of training provided;
- **Supply chain coordination:** Firms aiming to improve capabilities across the entire supply chain may address the following areas (though to some extent these types of effect might not be expected, at least to the same degree, for some of the single firm projects funded through the two regional rounds of AMSCI):
 - Improve communication and collaboration within chains by addressing how information is best shared – this could be investment in new inventory control tools or simply scheduling regular calls between production managers.
 - Train staff so that skilled and flexible labour across the supply chain can cope with fluctuations in demand, non-standard scenarios or crisis.
 - Address weaknesses in inventory management to reduce cost, where possible, and unnecessary delays in production. Supply chains should understand the differing role of the inventory – safety, replenishment, excess – and use the best production forecasting tools available based on sound strategic decision making.
 - Share contingency plans to minimize disruptions.
 - Enhance Intelligence gathering to monitor shared risks to production for early identification of problems. This could be regular updates from critical links in the supply chain (one that has the potential for most disruption if problems occur), or protocols to be followed when unusual or concerning delays occur (such as when a delay associated with a container ship delay exceeds a certain number of days).
- **Crowding out:** Any additional spending stimulated by AMSCI in these areas has the potential to lead to offsetting effects in secondary markets. Additional demand for plant equipment, research and development staff, or training provision may place pressure on the prices of these factor inputs, leading to reduced demand elsewhere in the economy, less likely historically, given prevailing macro-economic conditions.

If the collaborative project is successful (and has addressed the market failures highlighted above), then the impacts of all three types of activity might be expected to be observed in an increase in productivity (i.e. the efficiency with which inputs are combined by the firms concerned):

- **Capital investment:** If AMSCI subsidies have been targeted at those firms facing financial constraints due to imperfections in financial markets, then the firms concerned might be expected to achieve (or move closer to) an optimal allocation of factor inputs in the production process (and raising overall profitability). It should be noted that the few evaluations of programmes of capital investment subsidies exploring these types of effect in depth have found it difficult to demonstrate effects on productivity, raising concerns that in some cases, subsidies reach marginal⁵ capital investment projects rather than those that were constrained by genuine failures in financial markets. In such cases, the impact of subsidies may be to reduce overall

⁵ I.e. those projects where the present values of risk-weighted expected returns are less than the present value of the opportunity and depreciation costs involved.

social welfare (by encouraging inefficient allocation of factor inputs), though there may be compensating effects in the form of additional jobs or reduced unemployment⁶.

- **Research and development:** The adoption of more efficient processes or the production of higher quality products will lead to improvements in the total productivity of factors employed in production (and also reflected in higher average labour productivity). These types of effect are not typically realised quickly, as illustrated in a 2013 evaluation of ERDF support for R&D in Finland between 2000 and 2006 which showed that productivity gains did not begin to emerge until three years following the allocation of subsidies⁷. Given the long product development cycles involved in the industries targeted by AMSCI (such as the aerospace and automotive industries), such effects may not emerge for longer periods.
- **Training:** If the acquisition of new skills improves the productive capacities of workers (for example, to operate new technology), then this might also be seen in an increase in average labour productivity. In this case, the threat that trained workers might leave may mean that the productivity gains might be split to some extent between firms and workers (numerous studies have suggested that the returns on employer funded training are split equally between workers and firms⁸).
- **Supply chain efficiency:** Supply chains that address the issues arising from their interdependence (such as production cycles, demand fluctuation, strategic planning and investment decisions; and supply chain risk) should hope to see gains in their overall and individual efficiency (again, such outcomes may be less prominent for the single firm projects funded). If firms within the supply chain develop production runs that are more closely aligned, or are more effective in their communication, then the associated reductions in waste and inventory will reduce costs and increase allocative efficiency. Firms may simply spend less time on transactional activity among its suppliers and customers reducing the cost of inventory management. A secondary effect of enhanced supply chain efficiency is improvements in the resilience of the supply chain to risks associated with disruption (which may result from localised issues with suppliers, regional issues affecting infrastructure, or global risks that could hamper the delivery of inputs to numerous links in a chain). Enhanced resilience – arising from better communication, coordination and collaboration – will help with;
 - Supply chain pro-active risk strategy: the readiness of the supply chain to deal with threats to production.
 - Supply chain reactive risk strategy: its ability to respond quickly and effectively to production disruptions and overcome them

The effects of reduced exposure to risk of disruption may also be visible in supply chain insurance premia (where the reaction time of a supply chain can represent a competitive advantage). Where disruptions impact on multiple supply chains there is

⁶ 'The Causal Effects of an Industrial Policy,' Criscuolo, Martin, Overman and Van Reenan, CEP Discussion Paper 1113, 2012

⁷ 'The Impact of R&D Subsidies on Firm Innovation,' Bronzini and Paselli, Bank of Italy Discussion Paper 960, 2014.

⁸ See 'Forecasting the Benefits of the UK Commission's Portfolio of Investments,' Evidence Report 80, 2013, UK Commission for Employment and Skills. Available at

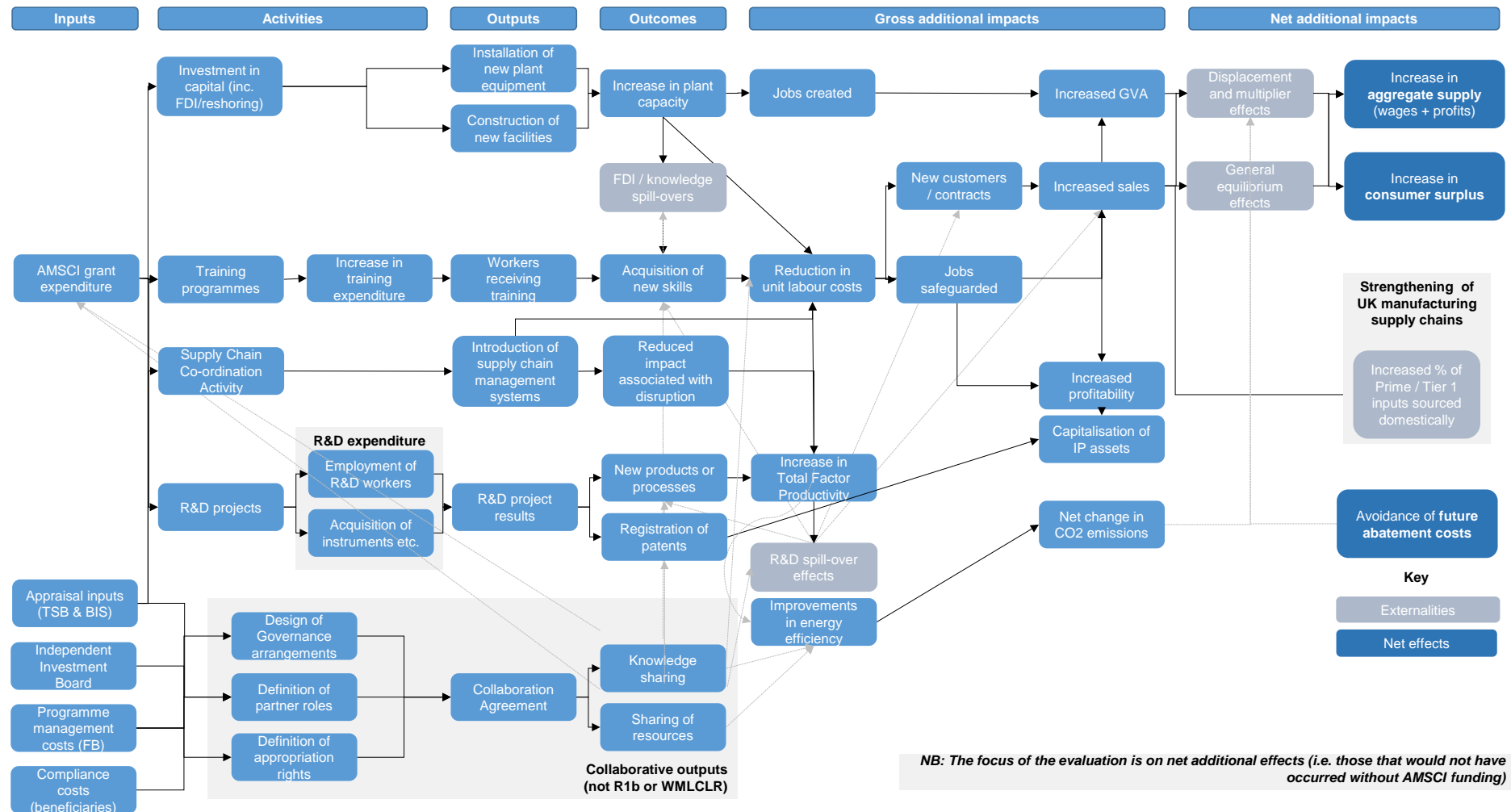
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/303349/forecasting_the_benefits_evidence_report_80.pdf (accessed October 2014).

an opportunity for the firms that recover quickest to capture demand in the absence of its competitors.

However, to the extent that these improvements in productivity are also accompanied by an increase in demand for these products, then increases in employment might be also expected. Equally, improvements in efficiency may also raise the competitiveness of the firms concerned, reducing the probability that Primes and Tier 1s source inputs from (or relocate production) to foreign territories (potentially leading to jobs safeguarded). Again, these impacts will have effects in secondary markets:

- **Product market displacement and multiplier effects:** Increases in production and market share will potentially be achieved at the expense of competitors (either competing firms within the supply chain, or other firms within the same industry). To the extent these competitors are based in the UK, there may be corresponding losses in employment (though if these firms were less productive, then such losses may be more than offset by benefits to the consumer in the form of lower prices or higher product quality). Equally, increases in production may lead on to increased demand for the inputs produced by supplier firms (leading to positive effects elsewhere in the supply chain).
- **Crowding out:** Increases in production will potentially be associated with greater demand for factor inputs, which may place pressure both on wages and the prices of intermediate goods and services. In the medium term, this may encourage other firms to reduce their consumption of these inputs, leading to offsetting effects (at the level of the whole economy). Equally, any human or other resources displaced in the short run will dampen pressure on factor prices, leading to the opposite effect. Once prices have adjusted, the medium term benefits of AMSCI projects are likely to be in the form of increases in the aggregate productive capacity of the economy (unless projects have also indirectly supported the absorption of under-utilised resources).
- **Spill-over effects:** Finally, AMSCI projects may lead to a wide range of spill-over effects that may not be captured by the firms concerned. These could include:
 - **R&D spill-overs:** Patents may not offer complete protection of the intellectual property generated through the delivery of AMSCI projects. Competitors may find patents straightforward to 'break', or find ways of building on the technologies protected, allowing them to exploit the innovation efforts of beneficiary firms. Additionally, churn in the labour market may lead to the transfer of knowledge to competitor firms. As such, there may be spin-off economic benefits of AMSCI (in the form of profits) that are not captured by the firms concerned.
 - **Environmental externalities:** Many AMSCI projects have energy efficiency objectives, with aims to reduce the cost of energy for the firms concerned. If projects are successful in meeting these objectives, then there may be broader environmental externalities associated with the projects in the form of reduced CO₂ emissions (as well other possible effects such as improved air quality). This will in turn lead to a reduction in the future cost of abatement (and possibly spin-off effects, such as health benefits associated with reduced levels of PM-10).

Figure 2.1: AMSCI Programme Logic



Success factors from literature: Trust and information sharing; prior experience of collaboration; stable personnel; geographical proximity to enhance communication (Cunningham and Gok, 2012).

- **Consumer surplus:** Improvements in productivity may not solely be captured by the firms concerned. For example, if firms seek to increase their market share through reducing their prices (and encouraging other firms to follow suit), then the welfare benefits involved may not be visible in improvements in firm profitability or productivity but enhanced consumer welfare. Estimating such effects would require an assessment of the causal effects of AMSCI on both overall level of consumption of the goods produced by the industrial sectors of interest, and their prices⁹.

A logic model for AMSCI is set out in Figure 2.1.

2.5 Key Outcomes

Table 2.1 sets out the range of effects that might usefully be explored through an impact evaluation of AMSCI (the next section examines how far it might be feasible to establish measures of these variables).

Table 2.1: Key Outcomes of Interest

Outcome Area	Key Outcomes
Inputs	<ul style="list-style-type: none"> • Capital expenditure • R&D expenditure • Training expenditure
Collaboration	<ul style="list-style-type: none"> • Collaboration agreements in place • Novelty of industrial collaborations • Stability of industrial collaborations • Resources committed to industrial collaborations
Capital outcomes	<ul style="list-style-type: none"> • Increase in capital stock • Re-shoring of operations from overseas territories to UK
R&D outcomes	<ul style="list-style-type: none"> • Technical progress • Patenting activity • Value of intellectual property • Introduction of new processes or products
Training outcomes	<ul style="list-style-type: none"> • Number of workers training • Level and type of training
Direct productivity effects	<ul style="list-style-type: none"> • Increase in average labour productivity (GVA per workers) • Increase in Total Factor Productivity (TFP)
Supply chain coordination	<ul style="list-style-type: none"> • Reduced supplier reliance • Improved contingency planning • Supply chain insurance coverage • Supply chain insurance premiums • Strategic visibility • System integration • Transaction cost savings

⁹ The value of consumer surplus can be approximated using a rule of thumb of that it is equal to half of the reduction in price, multiplied by the increase in consumption.

Outcome Area	Key Outcomes
Other direct economic effects	<ul style="list-style-type: none"> • Employment • Sales • Profits • GVA • Imports as percentage of inputs consumed (Primes)
Displacement and multiplier effects	<ul style="list-style-type: none"> • Displacement (jobs, GVA) • Supply chain multiplier effects (jobs, GVA)
Environmental externalities	<ul style="list-style-type: none"> • Net change in CO₂ emissions • Change in energy efficiency (CO₂ emissions per unit of output)
R&D spill-over effects	<ul style="list-style-type: none"> • Profit gains to non-beneficiary firm by exploiting R&D generated by AMSCI beneficiaries
Consumer surplus	<ul style="list-style-type: none"> • Output prices • Consumption

2.6 Wider influential factors

AMSCI has not been delivered in isolation, and there are a range of factors that would ideally be accounted for in a robust evaluation of the scheme. AMSCI was initially developed during a period of substantial economic distress that will have exacerbated some of the market failures identified above (particularly in terms of information asymmetries). As the economy recovers, it is likely that the strength of at least some of these market failures will ease, as well as influence the confidence of firms to make new investments in technology, which will be need to be considered in the impact evaluation (and some allowance may be needed accommodated time varying impacts, to test the hypothesis that projects funded in later rounds were less constrained by these issues). The economic recovery may also mean that the relative importance of effects driven by expansions in employment (that may have initially been dominant) will decline relative to effects driven by productivity growth.

Additionally, The Government has introduced a wide range array of interventions that might also be expected to contribute to similar outcomes. Where these interventions are universal in nature (such as tax incentives for research and development and other interventions designed to ease credit constraints), the incentives created would be expected to have an equal effect across beneficiary and any counterfactual group of firms used to assess the causal effects of AMSCI (and as such, it may be deemed less critical that these interventions are accounted for in analysis).

However, a large number of programmes have been created providing direct subsidies for capital, research and development and training expenditure (on both a single firm and collaborative basis). These schemes include the Regional Growth Fund, the Employer Ownership Pilot and numerous schemes named as part of the industrial strategy (such as the Advanced Propulsion Centre and the Aerospace Technology Institute funded by BIS, the Catalyst programmes and Catapult centres funded by Innovate UK). These schemes have led to substantial subsidies reaching similar sectors being targeted by AMSCI, with

the potential to distort the results of any impact evaluation of the programme, as a consequence of their direct or indirect influence on the performance of beneficiaries and any counterfactual group created to identify the impacts involved.

For example, the effects of AMSCI may be conflated with those delivered by other programmes if beneficiaries are simultaneously benefiting from multiple tranches of public subsidy (or if customers are benefiting from the subsidies provided through other programmes), causing an overstatement of the impacts involved. Alternatively, if any firms included in a comparison group are benefiting from the subsidies provided through other programmes, then this will lead to an understatement of the effects involved. Given these issues, it is critical that the evaluation is able to control for the other public support both beneficiaries and non-beneficiaries are receiving in order to separate the influence of AMSCI from those of other initiatives.

2.7 Regional Round 1 and WMLCR

AMSCI has involved two rounds in which the requirement for collaboration was relaxed: the Regional Round 1, and the West Midlands Liverpool City Region programme. The projects funded through these rounds have generally involved single firm, though subsidies have again been directed at capital investment, R&D, and training. As such, while the market failures involved may not be as acute as for the collaborative projects, they would be expected to deliver a broadly similar set of outcomes (other than those relating to collaboration and supply chain co-ordination).

2.8 Summary

- The rationale for AMSCI is underpinned by both traditional market failures associated with imperfections in financial markets, spill-over effects associated with R&D activity, and difficulties in internalising the full benefits of training. However, AMSCI has distinctive features in supporting collaborative industrial projects, which may fail to emerge even where it is in the best interests of the parties involved to collaborate, due to problems caused by the threat of free-riding, the incompleteness of contracts, and issues caused by uneven distribution of returns. Public subsidies (as well as the requirements for monitoring) for these types of collaborative project have the potential to address these market failures and strengthen the competitiveness of firms within the supply chain of large manufacturers.
- AMSCI projects might be expected to lead to range of intermediate effects that will need to be explored through the evaluation. These include raising capital, R&D and training expenditure amongst beneficiary firms (though the collaborative nature of the schemes means the expected direction of these changes may not be unambiguously positive). In turn, such changes would be expected to lead onto an increase in the capital stock, an acceleration of technical progress, the introduction of new products and processes, and increases in the numbers of workers trained.
- In turn, these effects would be expected to lead onto improvements in the productivity of beneficiary firms (both in terms of average labour productivity and Total Factor Productivity). If this translates into reductions in output prices, this may also lead to an increase in their market share, which may be accompanied by an increase in overall output (GVA) and employment. Such strengthening of the competitiveness of

manufacturing supply chains may also help beneficiary firms resist competition from non-domestic suppliers, reduce the dependency of Primes on inputs produced by overseas suppliers, and support domestic firms increase their export sales. Again, these will need to be explored through an impact evaluation.

- The evaluation would also ideally capture a number of potential effects on non-beneficiaries. While this would include the extent of any displacement from UK based firms operating in similar markets (or supply chain multiplier effects), AMSCI may also generate a number of spill-over effects through reduced CO2 emissions (as a consequence of enhanced energy efficiency), and through R&D spill-over effects.
- The availability of public subsidies for similar programmes of investment (including collaborative projects) raises a substantial risk for an impact evaluation. In particular, a study may conflate the effects of AMSCI with impacts caused by other Government programmes unless the receipt of subsidies provided through similar programmes (by both AMSCI beneficiaries and any counterfactual group of firms) can be adequately controlled for.

3 Measurement of Outcomes

This section explores the range of possibilities for measuring the key outcomes of interest (as defined in the previous section). A range of key options have been considered, including the data collected through the application, appraisal, and monitoring processes, data-linking to secondary sources, and primary surveys.

3.1 Mapping of Data to Key Outcomes

Table 3.1 provides an overview of the assessment set out in this section, mapping the key data sources to the outcomes of interest.

3.2 Monitoring Data

The management data collected through the programme (as explored in detail in Annex B), provides a range of information that could potentially be exploited through an impact evaluation of the scheme. These include:

- **Application data:** Applicants to the scheme are required to report employment and turnover for both the lead partners and any collaborators as part of their application, as well as other details (such as the industrial sector of participants) that might potentially be utilised as controls. This information could be potentially be used to set baseline values for an impact evaluation (though the absence of any validation of the data may mean that alternative sources - such as those described below - may be more robust).
- **Appraisal data:** The appraisal process has generated substantial information on the (assessed) qualities of the projects funded. These include the scores given through the technical appraisal process and a range of values associated with the VFM appraisal process (such as values for deadweight, displacement and the BCR). These values could potentially offer useful control variables for the purposes of matching similar projects. However, differences in the appraisal process between rounds, means that only the total technical score (expressed as a percentage of the maximum total) could be utilised in analysis spanning all rounds of AMSCI. Additionally, as not all bids have received a VFM appraisal, it may be necessary to exclude some observations from Round 1 and 2, and all observations from the Regional Round 1 and WMLCR to exploit this data.
- **Monitoring data:** Finally, monitoring covers the levels of capital, R&D and training expenditure associated with the projects, as well as the number of jobs created and safeguarded. These observations are available for all successful lead partners and collaborators, but as stressed in the Pilot Monitoring Report, will be of limited assistance in understanding the impacts of the scheme as they relate to the projects rather than the firms involved.

Table 3.1 - Mapping of Outcomes to Data Sources

Outcomes	Collected in MI	Potential to collect in MI	Business Structure Database	ARD	BERD	EPO Data	Meter Point	HMRC DataLab	Primary Surveys	Dunn & Bradstreet	Issues
Inputs											
Capital expenditure	No	Yes	-	Yes	-	-	-	-	Yes	-	Capital expenditure data is only available from secondary sources for large firms. Monitoring and/or primary surveys would be needed to collect observations for SMEs.
R&D expenditure	No	Yes	-	-	Yes	-	-	-	Yes	-	BERD data is only collected for known R&D performers. Monitoring could be adapted to collect this data, though surveys would be required to collect this data for comparison unit.
Training expenditure	No	Yes	-	-	-	-	-	-	Yes	-	There is no longitudinal data on training expenditure available in secondary data, and this would need to be gathered through monitoring and/or surveys.
Collaboration											
Collaboration agreements	Yes	-	-	-	-	-	-	-	Yes	-	Surveys of unsuccessful applications would be required to provide a comparison sample.
Novelty of collaborations	No	Yes	-	-	-	Yes	-	-	Yes	-	Surveys of unsuccessful applications would be required to provide a comparison sample. However, evidence on joint registration of patents is likely to provide superior measures.
Stability of collaborations	Yes	-	-	-	-	-	-	-	Yes	-	Surveys of unsuccessful applications would be required to provide a comparison sample.
Resources committed	Yes	-	-	-	-	-	-	-	Yes	-	Surveys of unsuccessful applications would be required to provide a comparison sample.

Outcomes	Collected in MI	Potential to collect in MI	Business Structure Database	ARD	BERD	EPO Data	Meter Point	HMRC DataLab	Primary Surveys	Dunn & Bradstreet	Issues
Capital expenditure											
Capital stock	No	No	-	Yes	-	-	-	-	-	-	Measures of the capital stock held in the UK (and therefore TFP measures) can only be established with longitudinal data on capital investment. This will only be available for large firms.
Re-shoring	Yes	No	-	-	-	-	-	-	Yes	-	The achievement of re-shoring objectives will be evident in monitoring information collected through AMSCI (though this will need to be extracted from narrative reports rather than through quantitative measures of outcomes involved).
Intermediate R&D outcomes											
Technical progress	Yes	Yes	-	-	-	Yes	-	-	Yes	-	Technical progress made by beneficiaries is gathered through monitoring, and further detail could be gathered through examination of the patents themselves.
Patenting Activity	No	Yes	-	-	-	Yes	-	-	-	-	EPO data are likely to be the most comprehensive source of data on patenting activity.
Value of Intellectual Property	No	Yes	-	-	-	-	-	-	-	-	The only realistic mechanism to capture the value of IP would be the monitoring process.
Introduction of new processes and products	No	Yes	-	-	-	-	-	-	Yes	-	There is no longitudinal data on the introduction of new products and processes available in secondary data, and this would need to be gathered through monitoring and/or surveys.

Outcomes	Collected in MI	Potential to collect in MI	Business Structure Database	ARD	BERD	EPO Data	Meter Point	HMRC DataLab	Primary Surveys	Dunn & Bradstreet	Issues
Training outcomes											
Number of workers trained (by type and level)	No	Yes	-	-	-	-	-	-	Yes		There is no longitudinal data on the introduction of new products and processes available in secondary data, and this would need to be gathered through monitoring and/or surveys.
Productivity gains											
TFP	No	No	Yes	Yes	-	-	-	-	-		It will only be feasible to examine TFP growth for large firms (owing to difficulties in establishing measures of the capital stock).
Average labour productivity	No	Yes	Yes	Yes	-	-	-	-	Yes		Evidence on average labour productivity could only be derived for large firms from secondary datasets. Surveys and monitoring would be needed to cover SMEs.
Supply chain coordination outcomes											
Supplier reliance	No	Yes	-	-	-	-	-	-	Yes	Yes	Where firms in the sample are very new or are an SME, there may be less credit history to make use of.
Supply chain length or complexity	No	Yes	-	-	-	-	-	-	Yes	Yes	Metrics around measures of supply chain complexity will rely on D&B specific analysis methodologies. These will need to be examined further as part of a main-stage study.
Contingency planning	No	Yes	-	-	-	-	-	-	Yes	-	This measure will likely be more apparent at the higher end of supply chains where production disruptions are likely to have a greater impact.
Supply chain insurance coverage and premium costs	No	Yes	-	-	-	-	-	-	Yes	-	Insurance for supply chains in high value added manufacturing industries are likely to be bespoke so the focus will need to be on changes in premia rather than absolute values.

Outcomes	Collected in MI	Potential to collect in MI	Business Structure Database	ARD	BERD	EPO Data	Meter Point	HMRC DataLab	Primary Surveys	Dunn & Bradstreet	Issues
Strategic visibility	No	Yes	-	-	-	-	-	-	Yes	-	Coordination across supply chains may be easily observed if individual firms are able to describe collaborators production strategies
System integration	No	Yes	-	-	-	-	-	-	Yes	-	Investment in shared transport, communication or monitoring systems will evidence improvements in supply chain efficiency
Cost analysis	No	Yes	-	-	-	-	-	-	Yes	-	Improved visibility of cost from shipping, storage and waste costs will also evidence efficiencies across the supply chain but may not always be directly related to supply chain level activities
Other Direct Economic Effects											
Employment	No	Yes	Yes	Yes	-	-	-	-	Yes		The BSD will provide longitudinal data on employment for beneficiaries and comparison group.
Sales	No	Yes	Yes	Yes	-	-	-	-	Yes		The BSD will provide longitudinal data on turnover for beneficiaries and comparison group.
Profits	No	No	Yes	Yes	-	-	-	-	Yes		Evidence on profits could only be derived for large firms from secondary datasets. Surveys and monitoring would be needed to cover SMEs.
GVA	No	No	Yes	Yes	-	-	-	-	Yes		Evidence on GVA could only be derived for large firms from secondary datasets. Surveys and monitoring would be needed to cover SMEs.
Exports	No	No	-	-	-	-	-	Yes	No		HMRC DataLab data could be used to establish measures of exports by beneficiaries, but there will be issues involved in obtaining access.

Outcomes	Collected in MI	Potential to collect in MI	Business Structure Database	ARD	BERD	EPO Data	Meter Point	HMRC DataLab	Primary Surveys	Dunn & Bradstreet	Issues
Imports of Primes	No	No	-	-	-	-	-	Yes	No		HMRC DataLab data could be used to establish measures of impacts by Primes, but there will be substantial issues involved in obtaining access.
Environmental externalities											
CO ₂ emissions	No	No	-	-	-	-	Yes	-	No		CO ₂ emissions can be derived from the electricity and gas consumption figures from the DECC Meter Point dataset, though there may be issues with coverage. Energy efficiency (CO ₂ emissions per unit of GVA) could be derived in combination with evidence on GVA.
R&D Spill-overs											
Profits accruing to non-beneficiaries	No	No	-	-	-	Proxy	-	-	No		Patent citations will provide a proxy measure for the presence of any R&D spill-overs.
Consumer Surplus											
Prices and consumption	No	No	-	-	-	-	-	-	No		There is no feasible means of exploring the consumer surplus effects of AMSCI.

The Pilot Monitoring Report highlighted a number of recommendations for enhancing the monitoring of the scheme. These included using the application process to collect additional longitudinal data across a broader set of outcomes (including capital expenditure, R&D expenditure, and training expenditure, and measures of profits, wage expenditure, and expenditure on finished goods and services), and using the monitoring process to track these measures over time at the firm level (on an annual basis over the duration of the project).

Recommendation

- Given the challenges highlighted below in collecting this data through other means, it is suggested that the recommendations of the Pilot Monitoring Report are adopted as rapidly as possible to maximise the availability of longitudinal data for an impact evaluation of AMSCI for successful applicants, i.e. firm level measures of:
 - Employment
 - Turnover
 - Capital expenditure
 - Value of capital assets (i.e. capital stock)
 - R&D expenditure
 - Training expenditure
 - Profits
 - Wage expenditure
 - Expenditure on finished goods and services
- Furthermore, these observations should be collected annually (possibly through the annual audit process) from a point in time pre-dating beneficiaries' involvement in the programme that is consistent across all rounds (e.g. 2010/11). For projects that have already started, this information should be gathered retrospectively. For AMSCI 2014 (and any future rounds), retrospective data should be gathered through the application process.
- Such an approach would not support the collection of data on any counterfactual group of firms (and corrective action cannot be taken for applications already received). However, it would substantially contain the challenges that might be faced as part of a main-stage evaluation.

3.3 VML datasets

The details of the various datasets that can be accessed via through the ONS Virtual Microdata Laboratory are presented below. In summary, the datasets within the VML can potentially supply longitudinal observations at a firm level for the following key outcome measures of interest:

- **Business Structure Database:** Employment and turnover (an annual snapshot of the Inter-Departmental Business Register).

- **Annual Respondents Database:** Capital investment and expenditures on goods and services (that can be used to derive measures of Total Factor Productivity¹⁰ and profitability), as well as GVA, though longitudinal data is only available for large firms (250 or more employees).
- **BERD:** Expenditure on Research and Development, though longitudinal data is only available for known R&D ‘performers’.

These datasets are linked via the unique reference number held within the IDBR, and if it is possible to identify AMSCI beneficiaries and non-beneficiaries within these datasets then this would potentially address many of the challenges associated with collecting quantitative data on these measures. This process is made more straightforward where it is possible to collect Companies House Registration Numbers, as ONS and BIS maintain a lookup table matching these registration numbers to their corresponding identifier within the Inter-Departmental Business Register.

Details of successful and unsuccessful lead applicants and partners were submitted by Aston Business School to test the feasibility of linking these records to the datasets concerned (the full sample of 679 organisations was supplied to Aston, of which 597 were businesses (176 were large firms, and 421 were SMEs). The results were as follows:

- **Business Structure Database:** 505 firms were matched to the Business Structure Database (a high matching rate of 84 percent). Longitudinal data covering the period 2005 to 2013 was available for 361 firms, and where years were missing this appeared to be primarily a function of the age of the firm (i.e. records were available for each year following their first appearance in the dataset).
- **Annual Respondents Database:** Only 47 firms were matched to the 2009 to 2013 Annual Business Survey, of which 25 only appeared once (implying that they were part of the sample survey of SMEs rather than the census of large firms). As such, it is highly unlikely that this dataset will offer sufficiently high coverage to offer a means of gathering information on GVA, capital expenditure and other measures.
- **BERD:** 180 firms were matched at least once into the BERD dataset (a matching rate of 30 percent).

A final issue to raise is that the BSD is based on a snapshot of the IDBR, which may not be fully up to date at the time it is taken (for example, employment records are in part based on PAYE records, which may be in extreme cases be up to four years out of date¹¹). As such, it is advised that a range of quality checks are made against alternative sources (such as monitoring data and baseline employment and turnover values gathered at the application stage), to establish how far any substantial lags are present in data that

¹⁰ Note that implementation of TFP methods require observations of the capital stock, rather than net capital investment. However, these issues can be addressed using the Perpetual Inventory Method (taking assumptions on the depreciation rates associated with different classes of capital asset, to provide an estimate of the capital stock surviving to the next period).

¹¹ Though a forthcoming study by Aston Business School, looking at the relationship between self-reported measures of employment and the BSD, suggests there is a high correlation between the two.

may need to be accounted for in analysis (the effects of lags in the data are likely to be less severe over evaluations with longer timescales).

Recommendation

- Data-linking to VML datasets should be exploited as far as possible to establish longitudinal records of the outcomes involved. This will supply comparatively high quality longitudinal observations on employment and turnover for a high proportion of firms, and a wider range of observations on measures critical in establishing any productivity effects for large firms (and potentially changes in R&D expenditure for a small subsample of AMSCI beneficiaries, though clearly this would have a negative effect on the sample sizes available for analysis).
- However, it will not be feasible to establish measures of productivity growth using the VML datasets. This is a problematic gap given the likely importance of understanding these outcomes in implementing the impact and economic evaluation framework outlined in the preceding section.

3.4 Wider Datasets

A range of wider secondary datasets were also considered (for more details see Annex C):

- **Patent data:** European Patent Office data could potentially be exploited to provide firm level measurements of joint patent registrations (as a measure of collaboration), patenting activity (as a measure of R&D output) and patent citations (as a means of capturing spill-over effects). In order to exploit this information to its fullest, it would be helpful for patent registration numbers to be captured through monitoring.
- **Meter Point data:** The Meter Point dataset could also be exploited to provide measures of the energy consumption of firms (gas and electricity). No difficulties were anticipated in accessing this DECC held dataset, though matching rates are not always high amongst non-domestic properties.
- **Trade Statistics:** HMRC holds firm level records of imports and exports which could be exploited to provide measures of how far the scheme has led to an impact in both helping beneficiaries export more finished goods, as well as identify how far primes have reduced the import share of their consumption. However, there are substantial challenges involved in accessing these datasets.
- **Supplier portfolio management data:** Dunn & Bradstreet compile data from credit sources and can provide a supplier analysis tool to identify risk within supply chains. Their datasets on supply chain allow them to make assessments on risk and reliance on individual suppliers or industry sub-sectors. Dunn & Bradstreet have almost complete coverage of UK firms and good coverage internationally, but reliance on credit data may be less useful where new firms are involved in consortia. The data is collected on an ongoing basis.

Recommendation

- Patent data should be exploited to explore the R&D effects of AMSCI, as well effects on collaboration, and to provide some insight into R&D spill-over effects. While these outcomes are of interest in understanding how AMSCI has met its objectives, they will be of limited assistance for an economic evaluation.
- Further qualitative data could be obtained through analysis of the patents themselves, though this would require additional monitoring information on the patent registration number associated with any patents registered as a consequence of AMSCI. It is recommended that this is captured through the progress updates collected by Finance Birmingham through their administration of the scheme.
- Despite issues with the potential data-linking process, it is recommended that best use of the Meter Point data is made as part of an impact evaluation to support an exploration of the energy efficiency objectives of AMSCI.
- It is recommended that BIS enter discussions with DECC to ensure that the appropriate data-sharing protocols can be put in place in advance of a main-stage evaluation of AMSCI.
- The obstacles to gaining access to HMRC data are substantial in that any research application will need to demonstrate that the study will benefit HMRC in particular (not just the Government in general).
- However, given the potential role of the trade statistics in resolving some of the most challenging issues associated with an impact evaluation of AMSCI), it is strongly recommended that BIS use its leverage to streamline access to HMRC datasets to enable the exploration of the issues identified above.

3.5 Prices and consumption

As highlighted in the previous section, an assessment of the consumer surplus benefits of AMSCI would require estimates of its causal effects on market prices and total consumption of the goods produced by beneficiaries. While there are secondary datasets that could provide some data on these issues (such as the producer prices series produced by the ONS), these datasets will not provide sufficient granularity on the specific products being produced by beneficiaries. Additionally, there is no data on total consumption broken down by product market that could be exploited as part of an impact evaluation. As such, exploring the consumer surplus benefits of AMSCI is likely beyond the limit of what is achievable through an impact evaluation of the scheme.

3.6 Value of Intellectual Property

The value of R&D activity might be loaded into any capitalisation of the IP rights, and could be a useful measure to track to capture the value of any intellectual property registered as a consequence of the programme. It is important to acknowledge that the value of IP may also be a flawed measure: if patents can be easily broken, which would dampen the overall value of IP generated through projects, while accountants may take a conservative view on the likely emergence of competitor technologies by heavily discounting future profits. However, the value of the asset is also benefit to the owner of that asset and would be ideally captured within an economic evaluation of the programme.

The annual audit process could potentially facilitate the on-going monitoring of the value of IP generated through the programme (as the Independent Accountant could validate any measures reported by applicants), as well as measures of the total value of IP held by the applicants concerned. However, it will be highly challenging to collect this data for a counterfactual group: while some firms may report the value of intellectual property holdings in published accounts, many of the SMEs involved will not be required to file anything more than total assets and liabilities at Companies House.

3.7 Spill-over Effects

The measurement of the spill-over effects (particularly the knowledge spill-overs that might be most strongly associated with the R&D projects through AMSCI) is likely to prove particularly challenging. In principle, the data collection methods specified above will capture the value of any spill-overs occurring within the supply chain collaborations that have formed to develop a formal proposal to AMSCI. However, establishing the nature of any spill-over effects occurring beyond those involved in the projects is made complex by the need to:

- Establish how far or whether a knowledge spill-over has occurred;
- Identifying the recipients of any knowledge spill-overs;
- Establishing the value of the knowledge spill-over (i.e. the impact of the spill-over productivity, which could be mediated through a range of different types of innovation).

The patent data described above can help provide proxy measures of the first two of these measures (i.e. through analysis of citations to patents registered by AMSCI applicants), though such records provide imperfect measures of spill-over effects. Firstly, not all knowledge spill-overs will be captured by citations (for example, some firms may choose to protect innovation through secrecy, and many types of spill-over effects will not be protected through patents). Secondly, some citations may be added to the patent by the patent examiner or attorney, implying that no spill-over effect has taken place. However, in the absence of detailed records of the linkages between firms and their workers, it will be highly challenging to provide a comprehensive quantification of the spill-overs occurring as a result of the AMSCI project.

A 2014 study for BIS¹² examining potential evaluation options for assessing spill-over effects suggests an alternative approach grounded in qualitative analysis, which might be employed as part of an evaluation of AMSCI. This framework recommends the assessment of the *potential* for a particular innovation to lead to spill-over effects through a qualitative analysis of the key features of the sector or technology area in which the innovation was developed:

- Generality of the technology or innovation involved (spill-overs will be more likely where the technology or innovation can find application in other contexts);
- Market structure (spill-overs may be higher in high value added or nascent industries)
- Institutional set-up (levels and nature of IP protection may have a positive or negative effect on the extent of spill-overs)

¹² An Economic Analysis from Programmes of Technological Innovation Support, BIS, March 2014

- Actors (spill-overs are made more likely where universities and research institutes are more active)
- Relationships between actors (spill-overs are more likely where networks are strong, or where there are collaborative agreements between actors)
- Transmission mechanisms (spill-overs are made more likely where there are more opportunities to transmit knowledge – for example, where labour mobility is high or as a consequence of industry specific publication practices¹³)
- Absorptive capacity (spill-overs are made more likely where firms or other actors are more able to absorb innovation).

However, while providing a helpful framework (particularly for ex-ante appraisal), it should be noted that its application will only provide insight into the potential for spill-overs to occur (and will fall substantially short of demonstrating how far such spill-overs have occurred in practice).

3.8 Primary Data Collection

There are a number of gaps in the availability of secondary data on the outcomes of interest (with particularly problematic gaps relating to the absence of the data needed to establish measures of the productivity gains associated with the programme – as only 47 firms could). Additionally, the range of control variables available is likely to be highly limited: covering a limited range of firm level characteristics (size, sector, and location) and the project level data captured through the application and appraisal process. There is a much broader range of characteristics of firms that are likely to be influential in contributing to the observed outcomes (such as attitudinal characteristics of managers), and the absence of this data may reduce the precision (or even bias) results.

As such, primary surveys of both beneficiaries and any comparison group may be needed to collect this information. However, there are a range of threats involved:

- **Baseline observations:** For many projects, the window for collecting baseline observations has passed. This means that surveys will need to try and establish baseline measures of the outcomes of interest on a retrospective basis (at least for those firms applying in earlier rounds). As such, any attempts to collect attitudinal data through surveys can be dismissed (though objective outcomes, such as R&D spending could potentially be observed).
- **Financial nature of the outcomes:** It will be very difficult to develop robust measures of some of the key outcomes absent in secondary datasets. For example, it will be difficult to implement a consistent measure of capital investment using survey based techniques (and it is likely that respondents will be unable to provide such information in telephone surveys unless substantial investment is made in preparing them for the interview). Advance data-sheets and targeting surveys at finance directors is likely to increase the quality of results, though there is a substantial data quality risk that would need to be considered.

¹³ For example, firms in the life science sector often publish results of clinical trials to encourage adoption or acceptance by national health systems.

- **Attrition:** A follow-up wave of surveys (or waves) would be required as part of a main-stage evaluation to gather further information on the outcomes of interest. This will introduce difficulties with attrition (particularly given the long timescales associated with outcomes involved, with some projects not due to complete until 2019), which will place pressure on sample sizes (which are not large to begin with). Attrition could potentially be minimised by maintaining engagement with the firms concerned (such as sending regular letters or other communication in the interim, as well as gathering portable contact details such as email addresses). However, attrition would also be substantially minimised (at least for successful applicants) by ensuring that up-to-date contact details for all lead applicants and partners are kept up to date systematically through the monitoring process (addressing the possible issues with staff moving on).

Recommendation

- Any primary survey of beneficiaries is likely to yield sub-optimal information on the outcomes of interest: the opportunity to collect baseline data has passed, and the financial nature of many of the outcomes may make them difficult to observe either reliably or consistently, and attrition in surveys (and the long timescales involved) is likely to place sample sizes under pressure.
- However, without implementing a survey, it will not be possible to collect the data on GVA, capital investment, R&D expenditure and other measures that will be critical in measuring the net resource costs associated with AMSCI and productivity benefits involved, without which any form of cost-benefit analysis will not be possible.
- Given these risks, it may be preferable to take corrective action with regard to the monitoring of successful applicants. This would limit the potential focus of a survey to a tracking survey of the appropriate comparison group, minimising the costs invested in primary data collection.

3.9 Monitoring of Wider Programmes

To separate the impacts of AMSCI from other programmes, it will also be necessary to collect monitoring information indicating the participation of firms in other programmes (as well as any non-beneficiaries selected as part of a comparison group). As part of the study, a review of the monitoring data collected through similar programme was undertaken to determine how far a supplementary set of controls could be derived from this dataset. Table D1 in Annex D provides the results of this review, and suggests that – at least for the largest schemes that are most likely to distort findings – systematic records are available.

Recommendation

- BIS should seek to obtain data-sharing agreements to exploit the availability of wider monitoring information on related programmes. This data should be collected as part of a main-stage evaluation to provide a supplementary set of control variables to accommodate the contributory effects of other programmes towards the outcomes of interest.

3.10 Summary

- **Data-linking:** Longitudinal records of a wide range of outcomes of interest are available through data-linking and these sources should be fully exploited before recourse is taken to less robust data collection methods. Secondary sources will provide comprehensive records on employment, turnover, patenting activity, and energy consumption. However, there will be major challenges in gathering the evidence needed on capital expenditure, GVA, profits and expenditures on goods and services to estimate the productivity effects involved. Finally, it may be feasible to gather further data on trade data if it is possible to access the HMRC DataLab.
- **Key gaps:** However, there are a range of key gaps: administrative data available provides no records of training expenditure or outcomes; measures of R&D expenditure will only be available on a longitudinal basis for known R&D performers; and it will not be feasible to estimate the net resource costs and productivity benefits using administrative data alone. This will substantially limit the potential scope of an economic evaluation.
- **Monitoring enhancements:** Monitoring processes could be enhanced to collect the financial data needed for successful applicants relatively robustly (as suggested in the Pilot Monitoring Report), and it is recommended that BIS make the necessary adjustments to simplify the potential data collection challenges associated with a main-stage study.
- **Primary surveys:** Primary surveys of beneficiary and non-beneficiary firms may be another means of filling gaps in the evidence base. However, owing to difficulties in measuring the variables of interest accurately, the time that has elapsed since some projects have been awarded funding and the likely sample attrition over the long timescales involved, such data collection methods will prove sub-optimal. In the absence of any alternative, it is suggested that primary surveys are adopted to generate longitudinal data for SMEs forming part of a comparison group (with the remainder of data supplied either through data-linking or monitoring).
- **Wider monitoring:** There is a wide range of monitoring information collected through some of the key Government programmes that are likely to be influential in contributing to the anticipated outcomes of AMSCI (including the large scale subsidies available through RGF, the Advanced Propulsion Centre, the Aerospace Technology Institute, and the Employer Ownership Pilot). This information should be gathered as part of a main-stage study, and BIS should seek to put the necessary data-sharing agreements in place with external partners.
- **R&D spill-overs:** Patent data could potentially be exploited to provide some measure of the R&D spill-over effects involved (through a citation study). However, establishing measures of the economic value of these effects (i.e. the profits accruing to non-beneficiary firms) will not be feasible, and will need to be excluded from any economic evaluation of the scheme.
- **Consumer surplus:** Collecting evidence on the price and consumption of the products produced by AMSCI beneficiaries (at a market level) will not be feasible. As

such, it will not be feasible to value any consumer surplus benefits as part of a main-stage impact evaluation of AMSCI.

4 Impact Evaluation Options

This section considers the range of impact evaluation options that might be applied to develop a robust assessment of the causal effects associated with the AMSCI programmes. This section gives detailed consideration to the issues that might be involved in constructing an appropriate counterfactual group of non-beneficiary firms, as well as explores the potential to apply a range of econometric techniques to as robustly as possible assess the impacts involved. This section also gives consideration to the risks associated with the small sample sizes available for AMSCI beneficiaries.

4.1 Counterfactual Definition

For the purposes of a main-stage evaluation of the AMSCI, the reference case for consideration has been assumed to be a scenario of no intervention through AMSCI (though not a scenario of no public subsidies for capital investment, training, or research and development, as beneficiaries may have otherwise been able to secure funding for their proposed activities through parallel schemes funded).

4.2 Selection bias and selection of counterfactual groups

An assessment of the impacts of AMSCI will require an appropriate counterfactual group of non-beneficiaries. As application to the programme is voluntary (and resources have been allocated through a non-random process preventing the possibility of an RCT), the selection of an appropriate sample of non-beneficiaries has the potential to substantially bias the results of any impact evaluation:

- Firstly, non-applicants to the programme are likely to differ substantially to applicants in ways that are likely to be correlated with the outcomes of interest. Even controlling for sector and size differences, non-applicants will differ in terms interest in pursuing collaborative industrial initiatives, and their relationships with customers, suppliers and HEIs that would enable them to plan and implement a collaborative industrial project. As such, drawing a comparison sample of non-applicants is highly likely to lead to an overstatement of the impacts involved unless all relevant factors motivating application to the programme can be somehow observed (and as the previous section has illustrated, the range of control variables available will be very narrow).
- Such issues could potentially be minimised by drawing a comparison sample from the pool of unsuccessful applicants. Unsuccessful applicants can be assumed to share similar observed and unobserved characteristics motivating application to the programme as successful applicants. However, the selective appraisal process is likely to raise concerns that unsuccessful applicants differ in systematic ways to successful applicants. For example, the VFM assessments are in part driven by assessor judgements about deadweight, and if these judgements are accurate then unsuccessful applicants are likely to be those most likely to take forward the collaborative project in the absence of AMSCI funding (causing an understatement of the impacts involved).

- On the other hand, estimates of the benefits involved are in part made on the basis of their potential to deliver job creation and safeguarding outcomes. This element of the appraisal process may imply that unsuccessful applicants have developed less effective technological proposals than successful applicants (causing an overstatement of the impacts of AMSCI).
- As such, it may be feasible to exploit the appraisal process further to refine the process of selecting an appropriate counterfactual. In particular, those bids that pass the minimum appraisal thresholds, but are rejected by the IIB, are those that are likely to be the most similar to successful projects (in terms of the unobserved factors motivating application to the programme and influencing success in the process).

Recommendation

- Given the nature of the scheme (and its emphasis on collaborative industrial projects), it is recommended that a counterfactual group is drawn from the pool of observations offered by unsuccessful applicants (rather than seek a counterfactual group of non-applicants to the scheme that may have had little interest in pursuing collaborative industrial initiatives).

4.3 Matching

Issues of selection bias can be partly addressed through selecting those potential comparison units that most closely resembles the characteristics of AMSCI beneficiaries (a process known as matching). If all factors driving selection into the programme can be accounted for, then matching methods have the potential to yield estimates of impact that are free of the issues of selection bias. This section explores the potential to match successful to unsuccessful applications rejected at the Independent Investment Board. The analysis focuses primarily on matching at a project level using the scores given through the appraisal process (which provide measures of the key factors influencing selection into treatment).

Table 4.1 gives average appraisal scores associated with successful applications, bids rejected at the IIB, and unsuccessful applications (note that this data does not cover the single firm projects funded through the WMLCR and Regional Round of AMSCI for which a VFM appraisal was not completed):

- **Unsuccessful versus successful:** Unsuccessful projects received lower technical appraisal scores and (where applicable) lower value for money scores in the appraisal process. Unsuccessful projects tended to be larger, involve smaller contributions from the public sector (as a percentage of cost), and involve higher levels of risk and rates of product market displacement. Unsuccessful projects also tended to involve a higher proportion of benefits driven by R&D spill-overs and training (and a lower proportion through jobs created indirectly).
- **Projects making it to the Investment Board:** Unsuccessful projects making it to the Investment Board were substantially more similar in their characteristics to successful projects. Again, these projects tended to be of a greater scale, with a smaller public

contribution to project costs, and higher estimated rates of product market displacement. These bids also involved a higher share of benefits being driven by ‘wider benefits,’ which often represented cost savings (that in many cases might be claimed as additional profits by the firms concerned).

Table 4.1: Average appraisal scores¹⁴ by type of applicant

Application	Successful	Rejected at IIB	All unsuccessful
Number of cases ¹⁵	58	15	110.0
Technical appraisal score ¹⁵	76.1	74.0	63.2
Appraisal score spread (min/max) ¹⁵	21.7	29.7	35.1
Opportunity Cost of Government Funding (£million)	£5.8	£7.0	£5.4
Total project cost (Private and government) (£million)	£15.9	£24.8	£13.8
Private Funding (% of total cost)	47%	53%	58%
Additionality measures			
Deadweight	54%	55%	50%
Factor Market Displacement	26%	29%	28%
Product Market Displacement	18%	27%	31%
Substitution Effects	7%	13%	16%
Risk Factor (%)	60%	45%	37
BCR	4.28	2.78	1.49
Decomposition of Benefits (% of total)			
Jobs Created	20	16	19
Jobs Safeguarded	17	11	14
Indirect Jobs	32	29	21
R&D Spill-overs	7	11	17
Training	8	7	10
Wider benefits	15	26	19

Source: Technical Appraisal from ‘Panel Sheets’ (TSB), VFM appraisals (BIS), and minutes of the Independent Investment Board

The small numbers of applications rejected by the IIB, as well as the preference of the IIB for projects associated with higher BCRs and technical appraisal scores, raises the challenge that there is not a substantial region of ‘common support’ for matches (i.e.

¹⁴ Averages exclude Round1, Stream 1 and Regional rounds (no VFM appraisals were done for these rounds)

¹⁵ All Rounds 1-4, including Round1, Stream 1 and Regional rounds

unsuccessful bids do not share similar characteristics to successful bids). This issue was confirmed when applying matching techniques to the data available using three different strategies:

- **Coarsened exact matching:** Coarsened exact matching seeks to match successful to unsuccessful bids on one to one basis where they share identical characteristics. The probability of finding a match is increased by 'coarsening' the matching variables (e.g. rounding BCR values to the nearest £0.10, for example, to increase the number of bids sharing identical characteristics). Application of this method found that in order to balance successful and unsuccessful samples, only three successful applications could be matched to unsuccessful applications, an insufficiently large sample to proceed with statistical analysis.
- **Propensity score matching:** Propensity score matching utilises the information available on the characteristics of the treatment and comparison groups to predict the probability that a particular firm is selected into treatment (the propensity score). The predicted probabilities are then used to match treatment and comparison units (i.e. where they share a similar predicted probability of receiving treatment). A calliper matching approach was used to test the efficacy of such a strategy, which led to 22 successful applications being matched to the 15 applications rejected by the IIB. While this led to a larger region of common support, the characteristics of successful and unsuccessful applications were not well balanced. In particular, the average BCR and technical appraisal scores were markedly (in excess of 40 percent) higher amongst the matched sample of successful applicants (though not statistically significant, owing to the small sample sizes and underlying variation).
- **Kernel matching:** Kernel matching techniques are similar to Propensity Score Matching methods. However, each treatment observation is matched to every comparison observation, using the propensity score as weight (with comparison observations that are very different to the treatment observation given a weight of zero). The application of this approach led to 28 applications being matched to the 15 applications rejected by the IIB, and delivered more balanced results than the Propensity Score Matching procedure outlined above. However, this remains a small proportion of the 58 applications that received funding through AMSCI.

Given these results, it is unlikely that matching strategies are likely to generate effective results in a main-stage evaluation of AMSCI as it will place substantial restrictions on sample sizes. Extending the pool of unsuccessful applications in the sample to those that did not make it to the IIB will exacerbate these difficulties (as these bids were less similar to those rejected by the IIB), as will the addition of firm level characteristics (as it will make it increasingly difficult for the statistical models to obtain close matches).

Recommendation

- The evidence suggests that the Independent Investment Board had a preference for bids with higher technical appraisal scores and Benefit to Cost Ratios. This causes substantial difficulties in identifying a region of ‘common-support,’ i.e. successful and unsuccessful applications do not share similar characteristics. As such, an approach grounded in matching is unlikely to prove an effective means of addressing the issues associated with selection bias, owing to the likely restrictions such an approach will place on sample sizes.

4.4 Longitudinal Panel Techniques

The availability of longitudinal data (as described in Section 3) will facilitate the construction of longitudinal panel covering both AMSCI beneficiaries and unsuccessful applicants. The application of longitudinal panel techniques extends the basic regression model framework to allow for unobserved factors that are invariant across time or invariant across observation units (or groups of observation units) - and are described as fixed effects. In practice, this involves adding a series of discrete variables to regression models to model the (hypothesised) unobserved factors of interest.

For example, if there is a concern that there are unobserved firm level characteristics that influence both participation and the outcome involved (that do not vary over time), these can be controlled for by adding a dummy variable to describe each firm in the panel. Such methods could be extended to include the following:

- **Appraisal scores:** Observed differences between the appraisal scores received by firms could be included within the model as time invariant effects. This would make the assumption that the appraisal scores reflected underlying characteristics of the firms involved that may help explain differences in the observed performance of successful and unsuccessful applicants over time. A dummy variable could also be included to describe whether the applicant made it to the Independent Investment Board to capture any unobserved differences between firms involved in applications passing and failing the minimum appraisal thresholds.
- **Time, sector or location specific effects:** There may also be unobserved shocks at a sector or location level (or within a particular time period) that may influence the outcomes of interest (as well as the probability of participation). These can also be controlled for with longitudinal data (though the extent to which it is feasible to do so will depend on the number of observations available).
- **Evolution of the programme:** Adjustments were made to the appraisal and selection process over time and the unobserved characteristics of firms benefitting from the programme may vary over successive rounds. However, this could be potentially controlled for by incorporating round specific fixed effects.

Application of this basic framework would potentially enable the entire sample of successful and unsuccessful applicants to be included in the analysis, and would yield generalizable estimates of the average treatment effects involved (and could therefore be used to draw general insights into the effectiveness of AMSCI). However, the models

would not be robust to changes in the unobserved characteristics of the firms involved, and given the systematic differences observed between successful and unsuccessful applications, there may be concerns over the robustness of such an evaluation strategy.

Recommendation

- Longitudinal panel methods (such as fixed effects models) are likely to prove more effective than matching methods in developing methods. Such methods can be made robust to any time invariant differences between successful and unsuccessful applicants, and would allow the full sample of successful and unsuccessful applications to be included in analysis.
- However, given the systematic differences between the two groups would raise concerns that failure to account for unobserved differences between the two that change over time may be leading to biased results. As such, it is suggested that these methods are included as a cross check on alternative approaches that may offer more analytically robust findings.

4.5 Timing of Rounds

AMSCI has been allocated over a series of successive funding rounds in the following financial years:

- 2012/13: Round 1.1, 1.2 and 2: 2012/13
- 2013/14: Round 3 and 4, and WMLCR
- 2014/15: AMSCI 2014

Given the potential availability of longitudinal data; it may be feasible to exploit differences in the timing of projects to generate superior results. This would involve using those firms receiving support in later rounds as a counterfactual for those in earlier rounds (using similar longitudinal panel methods outlined above).

By focusing only on those that were successful in the application process, such a strategy will (in principle) control for any unobserved factors motivating application for AMSCI funding as well as those influencing success in the project selection process. As an illustrative example, under these assumptions, if AMSCI has a permanent (or temporary) effect on the outcomes of interest, it should be visible in firm level observations associated with Round 1 and 2 applicants two years in advance of those associated with AMSCI 2014. Such an analysis could also be reconfigured to allow for project end dates (this is captured in monitoring), to explore the likely possibility that projects will only deliver commercial benefits once it is complete.

A range of further issues require consideration:

- **Systematic differences between applicants across rounds:** A key concern would be the presence of any systematic differences between applicants across rounds that are correlated with the outcomes of interest. Although the scheme has been made increasingly open to a wider a range of industrial sectors over time, these changes reflect an (exogenous) policy decision and would not necessarily be expected to be

correlated with the performance of successful applicants. However, AMSCI has also been delivered over a period of emerging economic recovery, which may cause unobserved differences between applicants between rounds (for example, in terms of appetite for risk). This is a potential risk to robustness, though it could be partly controlled for by allowing for a round specific unobserved fixed effect in regression models.

- **Sample sizes:** Such a strategy would restrict samples to the firms involved in successful applications (a total 274 firms), which would limit the statistical power associated with any analysis. Clearly, this would ease as a consequence of the additional bids funded through AMSCI 2014.
- **SMEs:** By restricting the focus to successful applicants, the problems outlined in the preceding section in relation to data availability for key outcomes amongst could potentially be resolved solely through adjustments to the monitoring process (i.e. there would be no need to survey unsuccessful applicants).

Recommendation

- Methods based on the timing of rounds have the potential to address many of the issues associated with delivering an evaluation of AMSCI, and should be fully explored as a part of a main-stage evaluation. Implementation does carry a risk to robustness in the form of the possible presence of unobserved differences between applicants across rounds, while sample sizes are a possible concern.

4.6 Regression Discontinuity Design

All AMSCI projects have had to pass a minimum score on a technical appraisal undertaken by a panel of independent assessors (defined as 70 percent of the maximum total score) to be considered by the Independent Investment Board. Additionally, many bids also received a VFM appraisal by BIS economists¹⁶, and again, applications needed to pass meet minimum BCR requirements to be considered by the IIB. These processes create a discontinuity in the assignment of AMSCI funding that can potentially be exploited in an impact evaluation through the application of Regression Discontinuity Design (RDD) methods.

The RDD approach effectively compares the outcomes associated with those bids just above the minimum scoring threshold against those just below to estimate the treatment effects involved (i.e. those that ‘just made it’ and those that ‘just missed out’). The approach rests on the assumption that while there may be systematic differences between successful and unsuccessful applicants in general, these differences will be effectively random at the threshold (giving the results a similar interpretation to those generated through an RCT). There are some clear analytical issues that would require resolution in the application of these methods to AMSCI:

¹⁶ In Rounds 1 and 2, those that passed the technical appraisal also received a VFM appraisal. In Round 3 and 4 and for AMSCI 2014, all bids received or will receive a VFM appraisal. Bids received for the West Midlands Liverpool City Region and the Regional Round 1 did not receive a VFM appraisal.

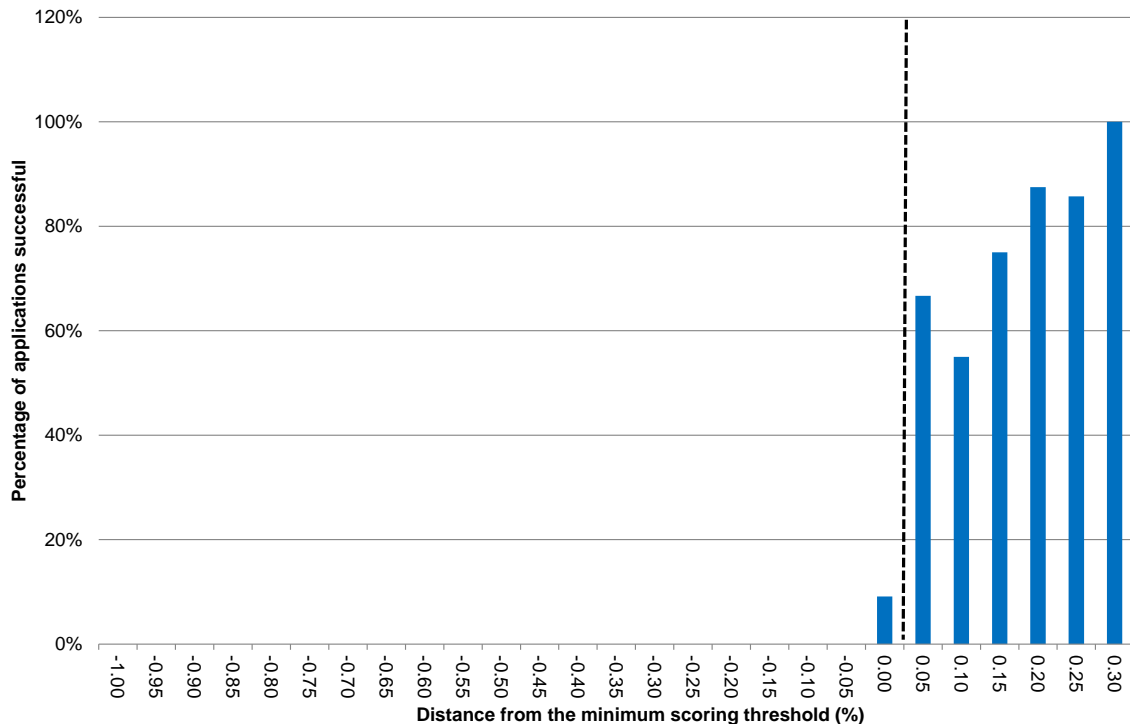
- **Creating an appropriate running variable:** The variation in the appraisal process over time creates some difficulties in creating an appropriate running variable to implement the RDD approach. Some bids received two appraisal scores (implying the presence of two discontinuities as illustrated in the diagram on the right), while others received a single appraisal score. Changes in the number of questions in the technical appraisal also led to changes in the absolute value of the threshold for passing the assessment. These complexities can be potentially be resolved by calculating the distance of each bids score from the minimum thresholds (as a percentage of the threshold score) to normalise across different rounds. Where bids have received a technical and VFM appraisal, the score that is furthest from the threshold is selected as the running variable¹⁷.
- **Fuzzy Regression Discontinuity Design:** The discontinuity created by the appraisal process does not create a ‘sharp’ division between successful and unsuccessful applicants for two reasons. Firstly, the Independent Investment Board does not accept all bids for funding (so some bids that pass the appraisal criteria are unsuccessful). Secondly, where a bid falls just short of the threshold score for the technical appraisal, the application enters a moderation process, which may lead to a re-evaluation of the technical score (which has led to a single ‘non-complier’ below the threshold, i.e. a bid that initially received an ‘Amber’ score in the appraisal process but was ultimately approved by the IIB). However, as Figure 4.1 shows, the probability of being successful changes discontinuously at the threshold, and a fuzzy Regression Discontinuity Design (FRD) approach will potentially be feasible. FRD methods can be implemented using Two Stage Least Squares. The first step estimates the change in the probability of receiving treatment at the discontinuity (the proportion of bids just meeting both the minimum technical and VFM scores required to be considered by the IIB that were successful in the process). These estimates are used in a second stage regression that models the impact of treatment (at the threshold).

In addition, a range of other factors will need to be considered in implementation:

- **Need for an interaction term:** Figure 4.1 below also shows that the probability of being successful in the application process increases with the value of the running variable (i.e. those bids with higher scores are more likely to be successful). If this is not accounted for in the application of these methods, then estimates of the increase in the probability of receiving treatment at the threshold (i.e. the first step of the analysis) will be biased. This could be accommodated by including an interaction term taking the value of zero below the threshold and the value of the running variable above the threshold in first stage regressions. Similar inspection of the relationship between the outcomes of interest and the running variable will be needed (at the point of analysis) to determine the appropriate functional form for the regression analyses.
- **Manipulation of treatment status at the threshold:** Another threat to the validity of the RDD approach is the potential for manipulation of treatment status at the threshold. If some firms at the threshold are able to influence their treatment status, then this

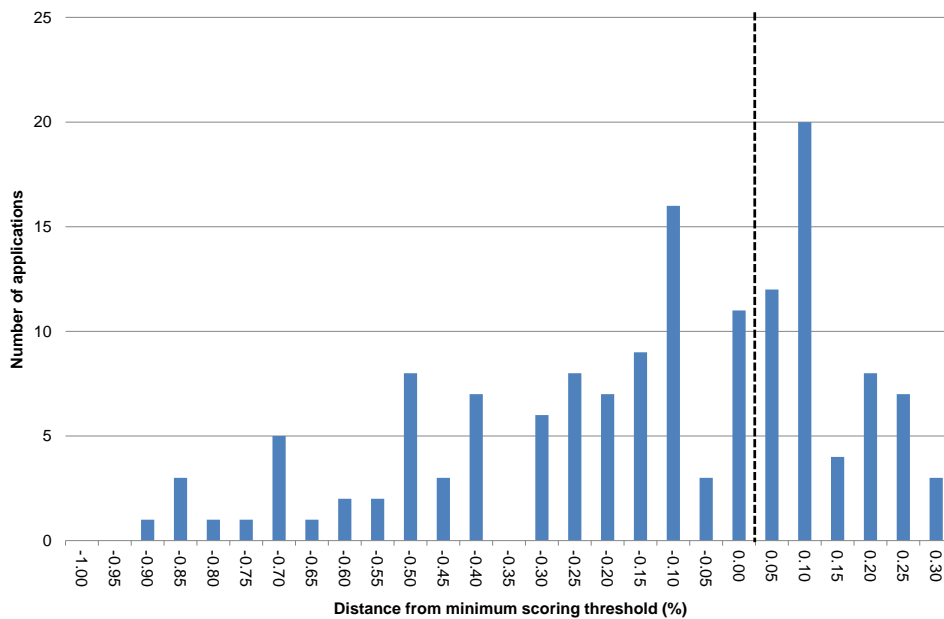
¹⁷ Formally, the running variable is defined as the $\min\{T - t, B - b\}$ where T is the technical appraisal score received, t is the minimum threshold score for the technical appraisal, B is the BCR score, and b is the minimum threshold score for the VFM appraisal.

Figure 4.1: Probability of assignment into treatment by distance from minimum scoring thresholds



Source: Technical Appraisal from 'Panel Sheets' (TSB), VFM appraisals (BIS), and minutes of the Independent Investment Board

would lead to systematic differences between the applications on either side of threshold with the potential to bias results. As recommended in Lee and Lemieux (2010) it is useful to seek evidence of such manipulation through graphical analysis of the distribution of the running variable: discontinuities in the distribution around the threshold are indicative of threats to the validity of the RDD approach. Figure 4.2 shows that there is a noticeable drop off in the distribution of appraisal scores just below the threshold. This may be coincidental, though it may also show reluctance on the part of appraisers to allow bids to 'just miss out.' A similar observation was made in a 2011 study examining the an Italian programme of R&D subsidies, though this was considered not to be problematic by the authors as there was no evidence that the firms themselves were able to influence their treatment status. However, there may be problems with such an assessment: if appraisers systematically favour bids with characteristics correlated with the outcomes of interest, then RDD estimates have the potential to be biased.

Figure 4.2: Distribution of assignment scores

Source: Technical Appraisal from 'Panel Sheets' (TSB), VFM appraisals (BIS), and minutes of the Independent Investment Board

- Statistical power:** Studies using RDD and FRD methods often aim to reduce bias by focusing on a bandwidth of observations close to the threshold (using local linear regression to more reliably estimate the size of the discontinuity at the threshold). Such approaches limit the number of observations available for analysis, and given the small numbers likely available for an evaluation of AMSCI, such refinements may not be feasible without substantially compromising the statistical power associated with the analysis. It may be preferable to use all observations in the analysis, and allowing for non-linearities in the relationship between the outcome and the running variable through the inclusion of higher order terms in the second stage equation (e.g. squared and cubed values of the running variable).
- Generalizability:** A final point that needs to be made about FRD methods is that while they are comparatively robust, the results involved are less generalizable than some of the other methods explored above: they only estimate the impact of treatment at the threshold (i.e. the effect of AMSCI funding on those bids just passing the technical and value for money appraisals). As the impact of funding could be very different for those bids with higher scores, it would be difficult to justify the use of such results in drawing general conclusions relating to the effectiveness of AMSCI (or use them to drive an economic evaluation of the fund).

Recommendation

- Fuzzy RDD methods are likely the most robust evaluation strategy available for the assessment of the impacts of AMSCI, and should form part of any main-stage evaluation of the programme.

4.7 Displacement and Multipliers

The assessment of displacement (and supply chain multiplier effects) is typically highly problematic in the evaluation of schemes such as AMSCI. As highlighted in a recent BIS ITT, there have been very few evaluation studies that have examined these issues robustly, and is particularly problematic as any cost-benefit analysis of AMSCI will require estimates of the net (rather than gross) additional effects of the programme. Estimating these effects robustly places substantial demands on data availability: in order to identify such impacts, the evaluator would need to identify the population of firms likely to be subject to effects (i.e. those competing in the same product markets and their suppliers), as well as potentially a counterfactual group of similar firms not likely to be subject to the same effects. This section explores the range of options considered.

a. Primary surveys

Many prior evaluation studies have attempted to explore these issues through primary surveys of beneficiaries. These typically involved asking the respondent to report the geographical distribution of their competitors, customers and suppliers, with a series of assumptions applied around the substitutability of the products involved to reach an estimate of the strength of displacement or multiplier effects involved. These approaches fall substantially short of demonstrating such effects have occurred (as they provide no empirical evidence of a reduction or increase in sales amongst non-beneficiaries as a consequence of the initiative).

b. Micro-data on non-beneficiaries

One possibility that may provide more robust results would be to define the group of firms potentially to be subject to displacement effects as all non-beneficiary firms operating within the same industry sectors as AMSCI beneficiaries. With longitudinal data for this panel of firms (using the IDBR as the sampling frame), a displacement effect might be estimated by allowing for a negative 'treatment' effect in fixed effects models from the year that their 'competitors' began receiving AMSCI subsidies (as multiple projects have been funded in the same sector, the treatment may best be modelled as the cumulative level of subsidies received by competitor firms). This approach would be similar to that outlined above involving exploiting the timing of rounds: sectors to which AMSCI subsidies were directed in later rounds would act as a counterfactual for those benefitting in earlier rounds.

In this the case, receipt of the 'treatment' might be thought of as exogenous (i.e. the receipt of subsidies by competitors can likely be assumed to be independent of the firm-level characteristics influencing non-beneficiaries' performance) and difficulties with selection bias less prominent. Such an analysis could also be modified to examine how far any social welfare benefits have arisen through displacement from less to more productive firms (by defining a control variable as the productivity differential – where data permits - between AMSCI beneficiaries and non-beneficiaries that interacts with the treatment variable).

However, there would be concerns that displacement effects would be too diffuse across the firms involved to allow them to be detected through such an analysis. These concerns could be minimised by restricting analysis to those non-beneficiary firms sharing the same

4 or 5 digit SIC code (though displacement effects may still need to be substantial for them to be visible, and such restrictions could increase the risk that displacement effects may be missed by narrowing the set of firms of interest too far). Such a method would also not go any way to addressing the issue of measuring supply chain multiplier effects. Despite these risks, there would be merit in pursuing these methods as part of a main-stage evaluation in the absence of alternative methods that have proven effective in the past.

c. Imports of Primes

If it is possible to access data on imports, it may be feasible to address the displacement question by examining how far AMSCI has led to causal effects in terms of reducing the import share of finished goods consumed by Primes and Tier One suppliers. This would yield estimates of the net increase in domestic demand stimulated by the programme (if there is no increase in the proportion of inputs sourced from domestic suppliers relative to a comparison group, then the inference would be that the scheme's effects would be represent total displacement).

Notwithstanding the aforementioned risks associated with obtaining access to the relevant data, there are some potential difficulties with such an approach. Firstly, as identified in Annex A, Primes and Tier One suppliers are not systematically reported through the application process, and while it is possible to identify a sample of Primes and Tier One associated with successful and unsuccessful bids, it is difficult to be confident that these data are comprehensive and robust (although adaptations to the application form could improve data availability for a future main-stage in this regard). Secondly, the sample sizes involved are likely to be small. As Annex A suggests, it may be feasible to construct a 'treatment group' of 56 treatment firms, and 'comparison group' of 11 unsuccessful firms from those bids that were rejected at the investment board. These constraints could be eased firstly through the funding of additional projects through AMSCI 2014, as well expanding the comparison group to include bids that failed the appraisal criteria.

However, there is also a possible issue in that the validity of the approach rests on the assumption that any improvements in productivity secured by suppliers do not translate into gains in market share for the Prime or Tier One manufacturers. As such, supplementary analysis exploring how far AMSCI has had an identifiable effect on the sales of these firms will also be needed (and if a causal effect is found, an assessment of impact that is net of displacement may need to be generated by scaling the overall effects involved downwards appropriately).

Recommendation

- Displacement effects will be highly challenging to deal with robustly through an evaluation of AMSCI, yet will be critical in delivering a robust impact and economic evaluation of the scheme.
- There are two possible strategies that are worth exploring as part of a main-stage: firstly, exploiting the availability of longitudinal data to determine how far a 'negative' displacement effect can be identified amongst non-beneficiary firms operating in the same sector. Secondly, an approach based on examining the causal effects of the proportion of inputs consumed by Primes through imports would provide estimates that are potentially net of displacement effects.

Recommendation

- Such methodologies are not without risks and it is not possible to offer assurances that they would work in practice. However, trialling these strategies through a main-stage would not be costly.

4.8 Dealing with small sample sizes

The small sample sizes available for analysis is potentially problematic, as depending on the strength of the effects involved, and the underlying variability of the data it may be difficult to identify statistically significant results. The availability of longitudinal panel data would potentially ease these constraints (if a ‘baseline’ of 2000 is selected for analysis, then by 2020, 20 observations will potentially be available for each successful and unsuccessful firm). However, the likely clustering of outcomes at a project level will have the reverse effect, though the design effect may not be large (for example, with 167 applications with a total 679 firms, and an inter-cluster correlation co-efficient of 0.05, this would reduce effective sample sizes by around 15 percent, to 580).

Nevertheless, it may be worth considering alternative strategies should analyses be underpowered:

- **Pooling AMSCI with other programmes:** There are a range of other schemes being delivered in parallel to AMSCI using very similar resource allocation process and the potential to deliver similar outcomes. These include the Advanced Propulsion Centre and the Aerospace Technology Institute (which involve subsidies for large scale collaborative R&D projects in the automotive and aerospace sectors respectively). These schemes also involve comparatively small numbers of projects, and pooling the observations associated with each of these programmes could potentially reduce the problems associated with small sample sizes. As these schemes also involve a scored application process, it may be feasible to adopt a similar strategy for identifying a counterfactual (though this would require systematic review). Further pooling with other initiatives being funded through the Industrial Strategy may also be feasible, but less attractive. For, example, the Innovate UK funded Biomedical Catalyst involves R&D subsidies for SMEs in the life science sector, though such a scheme is likely to lead to very different outcomes. It should also be noted that such pooling would substantially limit the granularity of any later evaluation, in that conclusions could only be drawn with regard to the effectiveness of R&D subsidies allocated through relevant schemes funded through the Industrial Strategy. As there may be interest in comparing the relative effectiveness of different initiatives to inform future funding decisions it may be preferable to undertake separate evaluations where possible (though it may be possible to accommodate this by allowing for unobserved scheme specific effects in regression models).
- **Case based approaches:** Qualitative case studies of a sample of projects would usefully form part of an impact evaluation programme. These would ideally be longitudinal in nature (reflecting the long timescales involved in the project), and would explore:
 - the progress made by the applicant towards the overall goals of the project,

- the intermediate outputs achieved, covering technological progress made, the capital investment made, and the characteristics of any training delivered,
- how these outputs have translated into improvements in operational efficiency, entry into new markets, shielded the firms from international competition, as well as any wider effects such as the formation of new and sustained collaborative relationships, and;
- evidence of any spill-over effects involved.

Case studies would span the following methods:

- **Synthetic control groups:** A quantitative analysis grounded in Synthetic Control Group methods, in which a 'synthetic comparison' is selected as the average of all possible comparison units (i.e. unsuccessful applications) weighted so as to minimise the observed differences against the case of interest (using the longitudinal data gathered through the processes identified above). This would provide indicative estimates of the impact of AMSCI on the outcomes of interest for the firms forming the focus of the case study, and would give a quantitative structure for the case study.
- **Analysis of MI:** An examination of the quantitative and qualitative monitoring information gathered by Finance Birmingham on the performance of the project and the results delivered. This could be usefully complemented by further analysis of secondary information (such records of patent activity).
- **Depth research with the firms involved:** Depth research with the applicants involved to develop a more detailed insight into the effects observed and how they have arisen. Of key interest will be establishing how far the projects themselves realised their anticipated commercial or technical goals (and where possible, it may be helpful if the case studies were extended to collect additional documentary evidence directly from applicants to establish how far the quantitative estimates of additional sales or cost savings provided in application forms were realised in practice).

Recommendation

- BIS should consider the merit of pooling AMSCI with other interventions such as the APC and the ATI to maximise the available samples for an evaluation.
- Case studies would form a useful complement to quantitative research, and could be grounded in quantitative methods through the application of synthetic control groups.

4.9 Randomisation

The most robust form of evaluation (RCTs) is not feasible owing to the design of the initiative. However, there may be an opportunity to adjust programme delivery mechanisms to make an RCT feasible while retaining many features of the existing process. In particular, the existing appraisal mechanisms could be retained to ensure that

bids meet certain minimum quality standards, and replacing the current project selection mechanisms with randomised resource allocation process (bids could be randomly selected for funding until the total funding available is allocated).

4.10 Summary

- **Impact evaluation methods:** Given the anticipated differences between and successful and non-applicants in this instance, it is suggested that a counterfactual sample is drawn from the pool of available of unsuccessful applications to minimise the challenges involved in addressing selection bias. There is no evaluation strategy that will design out all possible issues involved, and a hybrid strategy is suggested combining (1) fuzzy RDD methods, (2) approaches based on exploiting the differences in the timing of application rounds, and (3) general longitudinal panel methods.
- **Displacement:** Displacement is likely to be highly challenging to estimate robustly but is clearly central to developing a comprehensive understanding of the causal effects involved. The impact evaluation should explore the potential to identify a negative treatment effect amongst non-beneficiaries, as well as examine the causal effects of AMSCI on the import share of input consumption by beneficiary and non-beneficiary primes. These approaches are not risk free, and if there is little confidence in the results, this will need to be addressed in the economic evaluation (as discussed in the following chapter).
- **Sample sizes:** Sample sizes pose a risk to the impact evaluation and BIS should consider the potential to pool AMSCI with other programmes such as APC and the ATI to maximise the numbers of observations available. Additionally, case based approaches grounded in Synthetic Control Group methods may be a useful complement to quantitative analysis.

5 Economic Evaluation

Economic evaluation has two key forms: cost-effectiveness analysis (which explores the unit cost of the impacts or results delivered relative to other similar initiatives), and cost-benefit analysis (which places a monetary value on the impacts delivered and relates these to the costs involved). This section provides a framework within which a cost-effectiveness analysis and cost-benefit analysis could be implemented.

5.1 Costs

A comprehensive cost-benefit analysis of AMSCI will need to cover three forms of cost associated with the delivery of the programme:

- Costs incurred by BIS, the Innovate UK, members of the Independent Investment Board, and Finance Birmingham in the development and administration of the scheme.
- Costs incurred by applicants in the preparation of their applications, and where successful the transaction costs incurred through compliance with the obligations of the Final Grant Offer Letter.
- Additional resource costs incurred as a consequence of the subsidies provided through AMSCI (investment in capital, research and development, and training expenditure).

These costs (and issues involved in their valuation) are set out in the following sections.

Programme administration costs

The delivery of AMSCI involves a broad range of administration costs that should be included within the scope of CBA of the scheme. The appraisal process adopted for AMSCI has absorbed – and continues to absorb – a range of BIS and Innovate UK resources (largely in the form of staff time). This will cover both the development of a suitable appraisal methodology (and adjustments over time) alongside the time investments in undertaking the appraisals themselves. In addition, there will be costs involved in the project selection process (in terms of the opportunity costs associated with time invested by members of Independent Investment Board). Finally, Finance Birmingham will incur a wide range of resource costs in their administration and management of the programme¹⁸.

While administration costs associated with AMSCI are available directly from Finance Birmingham, it may be more challenging to estimate the costs of AMSCI to BIS, the Innovate UK and the Independent Investment Board unless the costs involved are captured under specific budget lines. An estimate might potentially be constructed using the Standard Cost Model (which values the cost of administrative processes as a function of the staff time they absorb, the wages of the staff involved, and the frequency with which

¹⁸ There are also potentially costs to other parts of the public sector through marketing and communications activity (for example, the roles played by BIS Local, the BIS Sector Teams, and LEPs in raising awareness of the scheme) that have not been considered here.

they comply with the process). As an example, if an estimate of the average length of time absorbed by appraisals can be developed, then this can straightforwardly be converted to an estimate of cost on the basis on the number of appraisal completed.

However, these administration costs are unlikely to be quantitatively significant, relative to the overall levels of subsidy channelled through the AMSCI programme). As such, it may be disproportionate to dedicate significant evaluation resource to estimating these costs through alternative methods if more precise measures are unavailable.

Recommendation

- The scale of programme administration costs are unlikely to be quantitatively significant relative to overall spending on AMSCI, and an element of judgement will also be needed to establish how far additional primary research would be appropriate given that these costs will have only a small influence on overall BCRs.

Transaction costs

Lead firms and consortium partners – both successful and unsuccessful – will incur a range of costs in the preparation of their applications and it is likely that a further group of firms which never get to the point of submission will incur costs in exploring the possibilities of the scheme. Successful bidders are also required to complete a range of administrative processes with associated costs to comply with the obligations of the Grant Offer Letter. This will include the completion of a due diligence exercise as well as regular requirements for monitoring the expenditure and outputs delivered by members of the consortia involved.

- **Possible quantitative significance:** The transaction costs associated with such compliance activities are not trivial: for the Regional Growth Fund, the average costs incurred by firms as part of the due diligence process was estimated at £13,500, while the cost of compliance with annual monitoring obligations was substantially lower.
- **Valuation:** These types of cost can be valued through adopting the Standard Cost Model (which values the cost of administrative processes as a function of the staff time they absorb, the wages of the staff involved, and the frequency with which they comply with the process). This will require the integration of appropriate questions into the surveys of successful and unsuccessful applicants.
- **Additionality:** Such costs may not be wholly additional. One of the market failures stressed in the literature as inhibiting collaborative industrial projects is an inability of firms to adequately monitor the resources committed by others to the project. Where unsuccessful applicants have taken forward projects without public sector support, it may be instructive to collect evidence on the mechanisms that have been adopted to resolve these issues (and the costs involved).
- **Other transaction costs:** The time taken by the appraisal and due diligence processes may have cost implications to the firms involved, potentially ‘freezing’ areas of activity

because of anticipated support which may ultimately not be forthcoming. Such costs to applicants may not be quantifiable but the issue still warrants exploration.

Evidence on these costs have been collected through the survey of applicants undertaken through the parallel process evaluation survey and should be incorporated in an economic evaluation of AMSCI.

Recommendation

- The process evaluation will provide a range of evidence that will be helpful in assessing the transaction costs involved with AMSCI.

Investment costs

The key set of costs that a CBA will need to account for in an evaluation of AMSCI will be the net impacts of the scheme on investment in physical capital, R&D and training. For schemes involving single firm interventions (such as RGF), the expected direction of change in these measures is unambiguously positive. However, in the case of AMSCI the nature of the effects involved is potentially ambiguous due to the collaborative nature of the projects funded.

The subsidies provided by AMSCI may encourage more efficient approaches to capital investment, R&D, or training (through collective purchasing of training, or where horizontal collaborations are involved, the avoidance of patent races). In such cases, the impact of AMSCI could conceivably be to reduce rather than increase collective levels of investment. However, this will also depend on how far private investment by individual collaborators acts as a substitute or a complement for investment through the collaboration (and in some cases, AMSCI may have an impact on investment that is in excess of spending on the project itself). As such, the observation of no change in investment amongst AMSCI beneficiaries may not necessarily be indicative of deadweight.

To drive this assessment, the impact evaluation will need as far as possible to estimate the causal effects of AMSCI on these measures. As such, longitudinal observations on capital investment, R&D expenditure, and training expenditure will need to be gathered through primary research, from secondary sources or through monitoring. The datasets in the VML cover both capital investment (through the ARD) and research and development expenditure (BERD), but are unlikely to be available for the full range of firms involved in AMSCI funded collaborations (though this will need to be confirmed through the data-linking exercise). However, further adjustments will also be needed for:

- **Depreciation:** The three forms of expenditure subsidised through AMSCI are likely to yield returns over multiple periods, and the additional expenditures incurred (or saved) should arguably be amortised over their economically useful lifespan¹⁹. It is unlikely that it will be possible to observe the rate of depreciation on these expenditures directly, and assumptions may need to be adopted on the basis of secondary evidence. There is substantial literature available on rates of depreciation of physical capital and of R&D

¹⁹ This differs somewhat from conventional accountancy practices under which R&D and training expenditures would normally be treated as in year expenses,

investments, though the literature on depreciation of training investment is less extensive.

- **Opportunity costs:** Alongside depreciation, it will also be important to account for the opportunity costs associated with the investments made. This might best be represented as the risk-free rate of return (i.e. the return on Government Bonds).

On-going costs

Where firms have made changes with respect to their working relationships and activities with the supply chain, there will likely be on-going costs associated with these activities (as well as investment costs outlined above). These costs could relate to more time invested in sharing information across the supply chain, shared activities related to production planning, pro-active risk management; or changes to inventory handling and transactions.

It is unclear from the literature whether these costs will represent net increase or decrease in revenue costs. If a firm is more effective in its transactional activity with suppliers and/or customers there could be, for example, an increase in the amount of time spent on each transaction (ensuring the production cycles of each firm are well aligned) but a decrease in the number of transactions that occur. Additionally there may be more labour time spent on the planning around production runs, communicating with firms, and forecasting demand for inputs and outputs, but the cost associated with the physical warehousing of these parts, both intermediate and final, will reduce.

These types of costs are likely to be difficult to capture directly through secondary data, though there may be scope through primary research to develop observations of the staff time invested in supply chain co-ordination activities. However, the net costs and benefits of supply chain co-ordination to individual firms will also be visible in measures of productivity gains (and as such, it may not be critical to observe these costs directly).

Study implications

- The extent to which a full cost-benefit analysis as part of a main-stage evaluation will be dependent on how far it is possible to assess the extent the impact of subsidies on levels of capital and R&D investment, and training expenditure. While this evidence might be in part available through data-linking, gaps in the data would need to be filled through monitoring or surveys of applicants.

5.2 Benefits

The benefits of AMSCI can be broadly broken down in terms of those accruing to the firms and workers involved directly in the collaboration, and any positive externalities associated with the projects that cannot be internalised by the firms involved.

Increase in output

The main benefits of AMSCI can be understood in terms of the increase in output (GVA) – or the sum of additional wages and profits accruing to workers and firms respectively. This increase in output can be understood as formed of two components:

- **Increase in productive efficiency:** An increase in output driven by an increase in the efficiency with which inputs are combined in the production process (which might be driven by a closer to optimal allocation of capital in the factor mix, the training of workers, or the adoption of new processes or products as a consequence of R&D). This will allow the firm to produce a higher value of output with the same inputs. Equally, the effects of improved supply chain efficiency will also be visible in improved productive efficiency.
- **Increase in quantity produced:** An increase in productive efficiency may also allow the firms concerned to reduce their prices, claim additional market share, and earn additional profits. If this market share is claimed from firms based within the UK, then there will be offsetting displacement effects that would need to be accounted for (as outlined in the preceding sections). However, if these effects have involved displacement from less efficient firms, then there will be social welfare improvements that would need to be accounted for in the analysis.

The impact evaluation strategies outlined in the preceding section would – in principle – permit the assessment of these effects directly. However, there are a range of issues and risks that need to be borne in mind:

- **Persistence:** In order to provide an assessment of the total benefits associated with AMSCI projects, it will be necessary to gauge the persistence the effects observed. A long term evaluation strategy will aid the measurement of persistence directly (and models could be adapted to incorporate a measure of the rate at which any effects decay over time). These empirical results could be adapted to make assumptions over the likely durability of the effects observed.
- **Displacement:** It may not be feasible to develop measures of displacement robustly. If the confidence in the results of the analyses suggested in the preceding section is low, then it is suggested that the analysis seeks to focus exclusively on the gains in productive efficiency with which existing inputs are used. This could be achieved using the results from the impact evaluation to decompose any GVA growth observed into a component driven by productivity gains and a component driven increased utilisation of factor inputs. This will likely understate the overall economic benefits of AMSCI, but will offer a result that is less likely to be subject to displacement effects.

Recommendations

- Estimates of the net increase in output should be used to drive a cost-benefit analysis of AMSCI. The impact evaluation should – in principle – provide the results required to do so (including potentially any welfare effects driven by displacement from less to more productive firms). However, there are substantial risks associated with obtaining robust measures of these externalities and if confidence in results is low, the evaluation should seek to value the improvements in productive efficiency rather than the overall GVA gains made.

Value of Intellectual Property

The emphasis of the programme on research and development raises the possibility that firms engaged in collaborative projects may gain assets in the form of Intellectual Property rights. To the extent that the collaborative project would not have proceeded in the absence of AMSCI subsidies, these assets should be considered as a benefit to the firms involved. At present, there is no monitoring of the value of any intellectual property created through AMSCI projects. However, their value may be captured in annual accounts under the subheading 'intangible assets' (this might capture the value of anything from patents through to customer relationships, all of which might be affected by a collaborative initiative). It is worth noting that values of formal IP vary from sector to sector as do the means for appropriation of benefits. Shared ownership of IP from collaborative projects can also add additional level of complexity. To the extent that the returns from ownership of the IP assets are reflected in firm profitability over the timescale of the evaluation no further allowance for their value will be necessary.

Recommendation

- The value of research and development of outputs are not currently captured through monitoring. However, it may be possible to monitor the value of IP created by changing the terms of reference for the annual auditors report to include an appraisal of the value of IP generated through the collaboration. However, as it will be challenging to estimate the causal effects of AMSCI on IP holdings, the value of intellectual property should be excluded from an economic evaluation.

Innovation Spill-over Effects

The main market failure justification used for subsidising research and development activity relates to positive externalities resulting from an inability of firms to fully internalise the benefits of innovation. This can occur through a number of mechanisms. Patent protection may be breakable if competitors can find alternative ways of implementing the innovation or developing innovations that build on the initial advances made (eroding the competitive advantage created by patents). Knowledge built-up in the firm may also be transferable via the labour market and the loss of research and development and other staff to competitors. Finally, supplier firms may also profit from the competitive advantage gained by customers through R&D activity (for example, manufacturers of car seats are likely to benefit from any increase in vehicle production). The social returns on R&D activity are likely to exceed the private returns, and where AMSCI has helped address these market failures driving sub-optimal investment in R&D, these externalities would ideally be monetised as part of a cost-benefit analysis.

A number of studies have sought to estimate the social returns associated with R&D expenditure. However, these studies have almost universally employed panel data on R&D investment and productivity at an industry or whole economy level, and to our knowledge no evaluation study has empirically demonstrated the external impacts of firm level subsidies for R&D using micro-data. Although econometric models are available to investigate these types of spill-over effect, they depend on an ability to identify the specific

firms that are likely to benefit from the spill-overs involved. Given the highly diverse nature of AMSCI projects, this issue is also likely to prove highly problematic in this context.

It may be possible to apply assumptions on the social rate of return to R&D expenditure to estimates of the causal effects of AMSCI on R&D spending to provide indicative estimates. However, this may prove problematic in this case owing to the collaborative dimension to many AMSCI projects: where public subsidies have encouraged more efficient allocation of resources to innovation, there is a possibility that AMSCI has a negative effect on R&D spending across consortia. In such a scenario, the adoption of such approach would lead to estimates suggesting AMSCI has generated negative externalities, which may not be appropriate.

Recommendations

- It will be highly challenging to empirically demonstrate the value of innovation spill-over effects (i.e. those benefits accruing to firms outside consortia) associated with AMSCI. While it may be possible to apply assumptions relating to the social returns on R&D to estimates of the impact of the scheme on R&D expenditure, the collaborative nature of the projects involve may make such an approach inappropriate. As such, it is suggested that R&D spill-overs are excluded from an impact evaluation.

Environmental externalities

As suggested above, it should be feasible to identify the causal effects of AMSCI on the overall electricity and gas consumption of the firms concerned. However, while there are standard methods for converting such effects into overall CO₂ savings, there are many analytical challenges that would need to be addressed in converting these measures into benefits that could be included within a CBA. In particular, the DECC Carbon Valuation methodology values future abatement costs on a global basis, and estimates of net CO₂ reductions should account for displacement effects globally (i.e. there will only be net reduction in CO₂ emissions if output is displaced from less to more energy efficient producers). It is beyond the limit of what is feasible to provide a robust account of these types of displacement effects, and it is suggested that energy efficiency effects are noted but not valued as part of a CBA.

Consumer surplus

Consumer surplus benefits may be an important benefit of the AMSCI programme. However, given the challenges involved in assessing the relevant causal effects of interest, the potential for such effects should be noted, but not value as part of the economic evaluation.

5.3 Benefit to cost ratios

Estimates of benefits and costs should be brought together in the form of a cost-benefit ratio in two different ways:

- **Benefit to cost ratio:** BCRs should be presented providing estimates of the net resource costs and benefits involved (note, given the data challenges associated with estimating the effects of AMSCI on SMEs, this may only be feasible for large firms);
- **Benefits per £1 of exchequer cost:** BCRs should also be presented as the ratio of net benefits to exchequer costs involved.

5.4 Cost Effectiveness Analysis

Alongside a cost-benefit analysis, the economic evaluation should seek to implement a range of cost-effectiveness analysis relating the net costs of the intervention to the effects involved, including measures of:

- **Cost per net additional job created:** Estimates of the net impacts of AMSCI should be related both to estimates of the net resource and Exchequer costs involved;
- **Cost per £1 of GVA created:** Additionally, the economic evaluation should seek to monetise the job creation and productivity impacts by providing estimates of the cost per unit of GVA created. These estimates could be driven directly by estimates from the impact evaluation (where it is possible to identify the effects involved), or through by applying assumptions on the average GVA produced per worker (using secondary evidence from the Annual Business Survey). While this latter measure may be unsatisfactory, it may be helpful if in cases where it is not feasible to estimate GVA impacts (for example, if it is not feasible to collect the relevant information needed for the SMEs concerned).

6 Conclusions

This final section sets out a specification for main-stage evaluation of the Advanced Manufacturing Supply Chain Initiative. This sets out the broad recommendations of the scoping report, considers the optimal timing of an impact evaluation, and key research components that will be needed.

6.1 Key Conclusions

This scoping review has suggested a main-stage evaluation would usefully focus on establishing the following outcomes:

- **Anticipated intermediate outcomes:** AMSCI projects might be expected to lead to range of intermediate effects that will need to be explored through an evaluation. These include raising capital, R&D and training expenditure amongst beneficiary firms. In turn, such changes would be expected to lead onto an increase in the capital stock, an acceleration of technical progress, the introduction of new products and processes, and increases in the numbers of workers trained.
- **Anticipated impacts:** In turn, these effects would be expected to lead onto improvements in the productivity of beneficiary firms (both in terms of average labour productivity and Total Factor Productivity). If this translates into reductions in output prices, this may also lead to an increase in their market share, which may be accompanied by an increase in overall output (GVA) and employment. Such strengthening of the competitiveness of manufacturing supply chains may also help beneficiary firms resist competition from non-domestic suppliers, reduce the dependency of Primes on inputs produced by overseas suppliers, and support domestic firms increase their export sales. Again, these will need to be explored through an impact evaluation.
- **Potential externalities:** The evaluation would also ideally capture a number of potential effects on non-beneficiaries. While this would include the extent of any displacement from UK based firms operating in similar markets (or supply chain multiplier effects), AMSCI may also generate a number of spill-over effects through reduced CO₂ emissions (as a consequence of enhanced energy efficiency), and through R&D spill-over effects.
- **Influence of wider programmes:** The availability of public subsidies for similar programmes of investment (including collaborative projects) raises a substantial risk for an impact evaluation. In particular, a study may conflate the effects of AMSCI with impacts caused by other Government programmes unless the receipt of subsidies provided through similar programmes (by both AMSCI beneficiaries and any counterfactual group of firms) can be adequately controlled for.

In terms of generating the necessary evidence for the evaluation, this scoping review suggests that:

- **Data-linking:** Longitudinal records of a wide range of outcomes of interest are available through data-linking and these sources should be fully exploited before recourse is taken to less robust data collection methods. Secondary sources will provide comprehensive records on employment, turnover, patenting activity, and energy consumption. However, there will be major challenges in gathering the evidence needed on capital expenditure, GVA, profits and expenditures on goods and services to estimate the productivity effects involved. Finally, it may be feasible to gather further data on trade data if it is possible to access the HMRC DataLab.
- **Key gaps:** However, there are a range of key gaps: administrative data available provides no records of training expenditure or outcomes; measures of R&D expenditure will only be available on a longitudinal basis for known R&D performers; and it will not be feasible to estimate the net resource costs and productivity benefits using administrative data alone. This will substantially limit the potential scope of an economic evaluation.
- **Monitoring enhancements:** Monitoring processes could be enhanced to collect the financial data needed for successful applicants relatively robustly (as suggested in the Pilot Monitoring Report), and it is recommended that BIS make the necessary adjustments to simplify the potential data collection challenges associated with a main-stage study.
- **Primary surveys:** Primary surveys of beneficiary and non-beneficiary firms may be another means of filling gaps in the evidence base. However, owing to difficulties in measuring the variables of interest accurately, the time that has elapsed since some projects have been awarded funding and the likely sample attrition over the long timescales involved, such data collection methods will prove sub-optimal. In the absence of any alternative, it is suggested that primary surveys are adopted to generate longitudinal data for SMEs forming part of a comparison group (with the remainder of data supplied either through data-linking or monitoring).
- **Wider monitoring:** There is a wide range of monitoring information collected through some of the key Government programmes that are likely to be influential in contributing to the anticipated outcomes of AMSCI (including the large scale subsidies available through RGF, the Advanced Propulsion Centre, the Aerospace Technology Institute, and the Employer Ownership Pilot). This information should be gathered as part of a main-stage study, and BIS should seek to put the necessary data-sharing agreements in place with external partners.
- **R&D spill-overs:** Patent data could potentially be exploited to provide some measure of the R&D spill-over effects involved (through a citation study). However, establishing measures of the economic value of these effects (i.e. the profits accruing to non-beneficiary firms) will not be feasible, and will need to be excluded from any economic evaluation of the scheme.
- **Consumer surplus:** Collecting evidence on the price and consumption of the products produced by AMSCI beneficiaries (at a market level) will not be feasible. As such, it will not be feasible to value any consumer surplus benefits as part of a main-stage impact evaluation of AMSCI.

In terms of an impact and economic evaluation methodology, the scoping review suggests the following:

- **Impact evaluation methods:** Given the anticipated differences between and successful and non-applicants in this instance, it is suggested that a counterfactual sample is drawn from the pool of available of unsuccessful applications to minimise the challenges involved in addressing selection bias. There is no evaluation strategy that will design out all possible issues involved, and a hybrid strategy is suggested combining (1) fuzzy RDD methods, (2) approaches based on exploiting the differences in the timing of application rounds, and (3) general longitudinal panel methods.
- **Displacement:** Displacement is likely to be highly challenging to estimate robustly but is clearly central to developing a comprehensive understanding of the causal effects involved. The impact evaluation should explore the potential to identify a negative treatment effect amongst non-beneficiaries, as well as examine the causal effects of AMSCI on the import share of input consumption by beneficiary and non-beneficiary primes. These approaches are not risk free, and if there is little confidence in the results, this will need to be addressed in the economic evaluation (as discussed in the following chapter).
- **Sample sizes:** Sample sizes pose a risk to the impact evaluation and BIS should consider the potential to pool AMSCI with other programmes such as APC and the ATI to maximise the numbers of observations available. Additionally, case based approaches grounded in Synthetic Control Group methods may be a useful complement to quantitative analysis.
- **Economic evaluation:** An economic evaluation (cost-benefit analysis) should be driven by primarily by net impact of the programme on output. The impact evaluation should – in principle – provide the results required to do so (including potentially any welfare effects driven by displacement from less to more productive firms). However, there are substantial risks associated with obtaining robust measures of these externalities and if confidence in results is low, the evaluation should seek to value the improvements in productive efficiency rather than the overall GVA gains made. Additionally, there will be no feasible means of valuing the effects of AMSCI in terms of R&D spill-overs, value of intangible assets, improvements in environmental efficiency, or consumer surplus.

6.2 Recommended Main-Stage Specification

It is anticipated that a main-stage impact evaluation of AMSCI would focus on examining the causal effects of the programme on the outcomes (considering what it may be feasible to measure on a longitudinal basis). In summary:

Outcome Area	Key Outcomes
Inputs	<ul style="list-style-type: none"> • Capital expenditure • R&D expenditure • Training expenditure
Collaboration	<ul style="list-style-type: none"> • Joint registration of patents (proxy measure)
Capital outcomes	<ul style="list-style-type: none"> • Increase in capital stock
R&D outcomes	<ul style="list-style-type: none"> • Patenting activity
Training outcomes	<ul style="list-style-type: none"> • Number of workers trained • Level and type of training
Direct productivity effects	<ul style="list-style-type: none"> • Increase in average labour productivity (GVA per workers) • Increase in Total Factor Productivity (TFP)
Other direct economic effects	<ul style="list-style-type: none"> • Employment • Sales • Profits • GVA • Imports as percentage of inputs consumed (Primes)
Displacement and multiplier effects	<ul style="list-style-type: none"> • Displacement of jobs and GVA • Welfare improvements driven by displacement from less to more productive firms
Environmental externalities	<ul style="list-style-type: none"> • Net change in CO₂ emissions • Change in energy efficiency (CO₂ emissions per unit of output)
R&D spill-over effects	<ul style="list-style-type: none"> • Patent citations

The impact evaluation would involve:

- **Counterfactual:** Given the anticipated differences between and successful and non-applicants in this instance, it is suggested that a counterfactual sample is drawn from the pool of available of unsuccessful applications to minimise the challenges involved in addressing selection bias.
- **Impact evaluation methods:** There is no evaluation strategy that will design out all possible issues involved, and a hybrid strategy is suggested combining (1) fuzzy RDD methods, (2) approaches based on exploiting the differences in the timing of application rounds, and (3) general longitudinal panel methods.
- **Displacement:** Displacement is likely to be highly challenging to estimate robustly but is clearly central to developing a comprehensive understanding of the causal effects involved. The impact evaluation should explore the potential to identify a negative treatment effect amongst non-beneficiaries, as well as examine the causal effects of AMSCI on the import share of input consumption by beneficiary and non-beneficiary primes.

An economic evaluation would focus largely on attempting to estimate the net costs and benefits involved as specified in Section 5. However, if it is not feasible to develop robust estimates of displacement, it is suggested that the focus moves to examining the increase in the productivity efficiency with which existing inputs are used (as this will provide a measure of the net benefits involved that are likely net of any displacement).

Data Collection

An impact and economic evaluation will be largely achievable through exploitation of secondary datasets (including the datasets held within the VML). However, there will be some key gaps in the evidence base with regard to the SMEs benefitting from the programme, that would optimally be filled through adjusting monitoring processes (or sub-optimally through a programme of primary research). There are clearly three potential options to proceed:

- **Do nothing:** While a range of causal effects could potentially be explored through a main-stage (primarily those relating to effects on employment and turnover), a full cost-benefit analysis of AMSCI would not be feasible.
- **Adjust monitoring (preferred):** Collection of additional longitudinal data from successful applicants would address the main data collection challenges, and offer more robust measures than alternative methods. Analyses based on exploiting differences in the timing of rounds would address the issues caused by the lack of observations on some key variables for the comparison group.
- **Primary surveys:** Primary surveys (targeted at SME unsuccessful applicants) could also be used to fill the gaps in the evidence base. These would be suboptimal, and would need to begin as soon as possible to collect baseline observations.

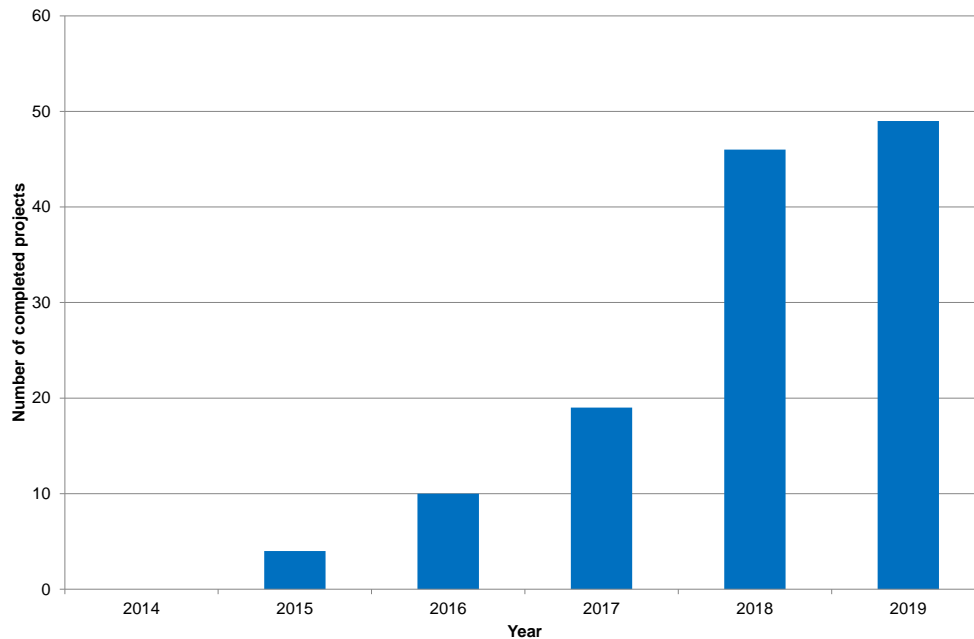
Timing

Figure 6.1 shows the estimated completion date of AMSCI projects funded to date. This suggests that the majority of projects will complete by 2018, and allowing three years for impacts to accrue, a final evaluation study is suggested in 2021. There may also be interest in undertaking a supplementary interim impact evaluation study in 2018 (though this would unlikely give a comprehensive assessment of the impacts achieved).

Optional elements

Finally there are additional elements that may be considered:

- **Updated process evaluation:** The evaluation would be usefully complemented by an additional process evaluation element focusing largely on the performance of the projects funded through AMSCI in delivering against their contracted targets for defraying AMSCI grant expenditure, total project expenditure, and jobs created and safeguarded (and any other KPIs introduced to monitor other outputs that may be introduced). This would be driven largely by an analysis of the monitoring information collected through the administration of the programme.

Figure 6.1: Estimated year of completion of AMSCI projects

- Pooling AMSCI with other programmes:** BIS should consider the potential for pooling AMSCI with other schemes with similar objectives and resource allocation mechanisms (such as APC and ATI) to maximise the number of observations available for robust analysis.
- Case based approaches:** Qualitative case studies of a sample of projects would usefully form part of an impact evaluation programme. These would ideally be longitudinal in nature (reflecting the long timescales involved in the project), and would involve a combination of quantitative analysis via Synthetic Control Group methods alongside analysis of MI, other secondary sources and depth research with applicants. It is anticipated that a sample of 10 projects would be sufficient to cover the variability of the scheme in terms of the sector and project mix. Ideally, case studies would be delivered in two waves (in 2018 and 2021) to align with the overall timing of the impact evaluation.

Annex A: Description of AMSCI

This section provides a descriptive overview of the Advanced Manufacturing Supply Chain Initiative. It covers the aims and objectives of the programme, the processes involved in delivery, and an overview of the characteristics of the applications received, projects funded, and the firms benefitting from subsidies.

A1 Aims and Objectives

AMSCI is a competitive fund that provides subsidies for capital investment, research and development expenditure and training for industrial projects involving collaborations across supply chains (including projects involving the re-shoring of manufacturing operations to the UK). The AMSCI has the following stated aim (set out in the 2011 Business Case):

‘to increase manufacturing sector growth potential by addressing market failures to improve the competitiveness of England-based Supply Chains to globally competitive levels.’

In addition, the 2011 Business Case sets out the following objectives:

- Create more competitive supply chains that anchor high value-added work in England;
- Increase levels of purchasing from UK supply chains by Primes/Tier 1s;
- Attract new customers to existing supply chain companies and sustain or create new employment opportunities;
- Create better synergies and sustained collaborative relationships throughout targeted supply chains;
- Prime / Tier 1 involvement and grant competition targets public resource on greatest sector growth opportunities and levers in significant private investment;
- Enhanced Government reputation for promoting growth and rebalancing the economy.

No major revisions to the objectives of AMSCI were made in a reiteration of the 2014 Business Case (although the emphasis on re-shoring was increased substantially).

A2 Resource Allocation Process

To date, AMSCI has been delivered as a contestable fund over seven discrete funding rounds. Applicants for funding submit an application form which is subject to an initial scope check (to verify that the bid meets the eligibility criteria for funding, such as the requirement for collaboration). If the submission passes the scope check, the bid is then subject to an appraisal process. This appraisal process has two dimensions:

- A technical appraisal focusing on issues of technical feasibility, in which five independent experts score the application from 1 to 10 against a set of pre-defined criteria. A minimum score of 70 percent is required to pass the technical appraisal (though those fall just short of this threshold enter a moderation process, in which a

panel of moderators re-evaluate the bids with a view to making a decision on whether any of those bids have should be considered for funding).

- A value for money (VFM) appraisal undertaken by BIS economists. The value for money assessment aims to provide an estimate of the likely net (non-private²⁰) benefits of the project relative to the costs to the public sector. The appraisal considers benefits in the form of wages accruing to the expected additional workers employed directly or indirectly by the applicant, increases in wages accruing to workers receiving training funded through the project, the value of R&D spill-overs, and any wider benefits that can be monetised. Issues around displacement, substitution, leakage and risk are also factored into the assessment. The application must deliver a benefit to cost ratio above a minimum threshold in order to pass the VFM appraisal.

If the application passes both appraisals, the bid, appraisals (and supplementary information on the financial health of the companies involved) is given considered by an Independent Investment Board to reach a decision on whether to fund the project. The considerations of the IIB revolve around how far the application aligns with the overall objectives of AMSCI, the technical feasibility of the project, the level of risk involved, and issues of return on public sector investment.

There has been some variability across the various Rounds of the programme in the resource allocation process:

- **Rounds 1 and 2:** The technical appraisal involved an assessment against nine criteria, while only those bids that passed the technical appraisal received a VFM assessment by BIS.
- **Regional Round 1:** A regional round (using unallocated funding from Round 1) was funded, in which the requirement for collaboration was relaxed (implying that bids involving a single firm could receive funding). These bids were only subject to a technical appraisal (using the same format as for Rounds 1 and 2).
- **Rounds 3 and 4:** Adjustments for Round 3 and 4 included an increase in the number of criteria involved in the technical appraisal to ten items (from nine). All bids received a VFM appraisal by BIS economists.
- **West Midlands Liverpool City Region:** Finally, a second regional round was funded (again, with the requirement for collaboration relaxed). Again, these bids were subject only to a technical appraisal against a reduced set of seven criteria.
- **AMSCI 2014:** Although retaining the broad principles of Rounds 3 and 4, the resource allocation process for AMSCI 2014 has been adjusted to allow applications to be received at any point over the course of the programme.

Table A1 provides details of the number of applications received and their success in the application process. A total of 168 applications were received across the various AMSCI funding rounds (excluding AMSCI 2014), of which 12 of these were repeat applications (an

²⁰ i.e: profits for the firms involved are excluded in the appraisal process.

application associated with one project was submitted in three funding rounds, implying 157 unique applications were received). 73 of these bids passed both the technical and (where relevant) the VFM appraisal, and were considered by the Independent Investment Board. This led to the approval of 58 projects for funding.

Table A1: Number of applications to AMSCI by Round

Application	Round 1.1	Round 1.2	Round 2	Round 3	Round 4	WMLCR	Total
Total applications received	10	22	41	24	51	20	168
Number of repeat applications	0	0	2	3	7	0	12
Number of unique applications	22	22	30	30	34	0	157
Bids passing technical and VFM appraisals (where relevant)	5	9	14	11	15	19	73
Number of projects funded	3	9	13	5	9	19	58

Source: AMSCI application forms held by Finance Birmingham

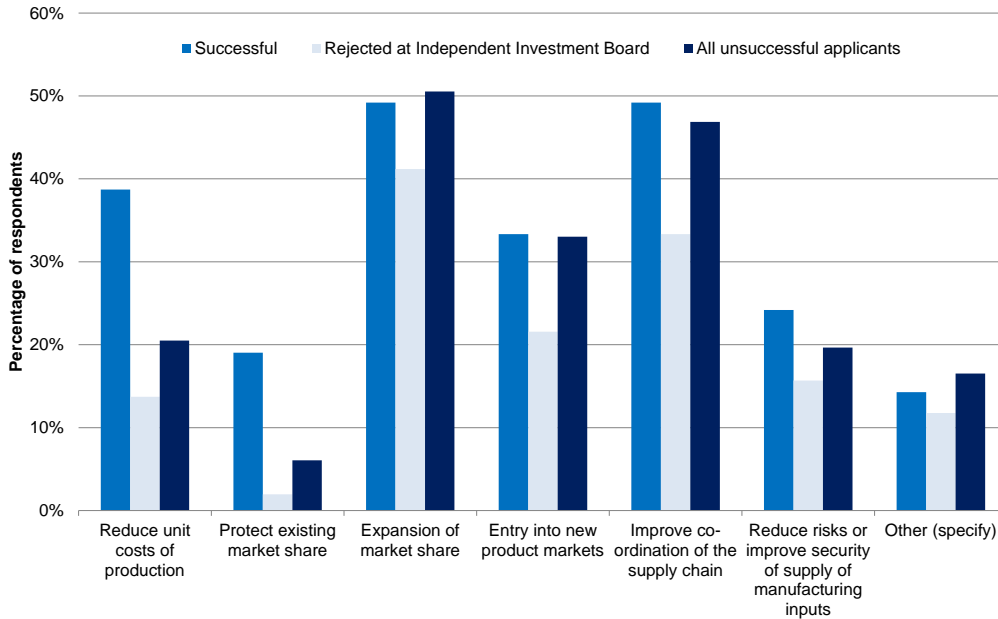
A3 Characteristics of Projects

The applications associated with successful applications for funding have been examined in depth and classified against an initial typology describing the key features of the bids involved (in terms of their goals, spending, market failure justifications, and collaborative features). The classification framework was developed initially through a detailed examination of 15 applications, before iteratively refining the framework through its application to the remaining successful applications.

Project objectives

Respondents to the survey that took place as part of the Process Evaluation were asked to report the main business objectives associated with AMSCI projects. As suggested in Figure A1, respondents indicated that AMSCI projects mainly involved some form of process or product innovation (with the emphasis on the former rather than the latter). In addition, the emphasis of both process and product innovation was on frontier technology (bringing wholly new products or processes to market) rather than catching up with competitors (i.e. innovations new to the firm). Around a third of successful projects also involved an emphasis on up-scaling production capacities to produce existing products. Few projects involved re-shoring objectives (the relocation of production facilities to the UK from overseas).

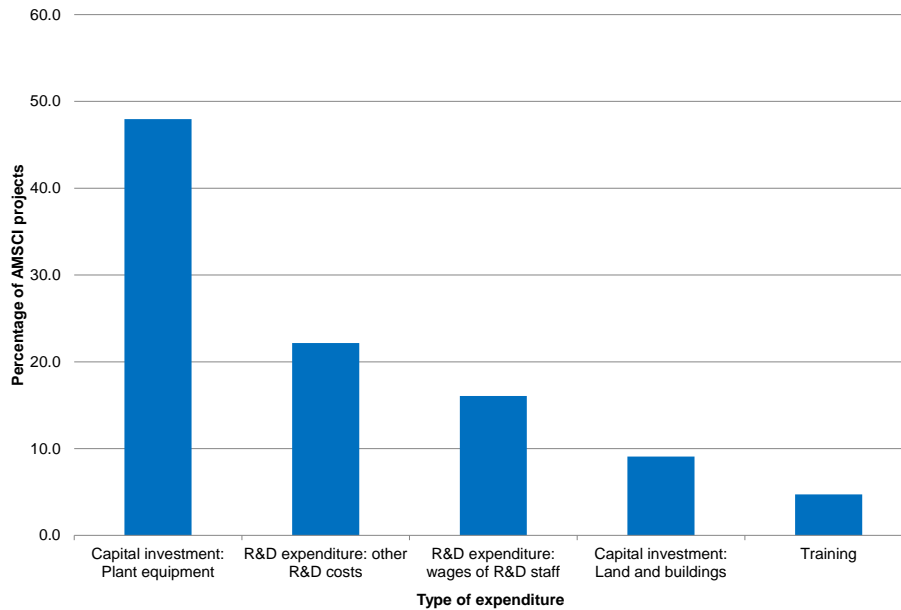
Figure A1: Main business objectives of AMSCI projects



Source: Survey of applicants (Base: 203 lead applicants and partners)

Project spending

The spending of AMSCI projects has been classified in terms of type of capital spend (land and buildings or plant equipment), type of R&D spending (wages associated with R&D staff or other R&D project costs), and training expenditures. Figure A2 shows that close to half of the expenditure associated with AMSCI projects is in the form of capital investment in new plant equipment, with a further 40 percent associated with R&D project costs or the wage of R&D staff. Training expenditure was only a small component of project spending (4 percent of total project costs).

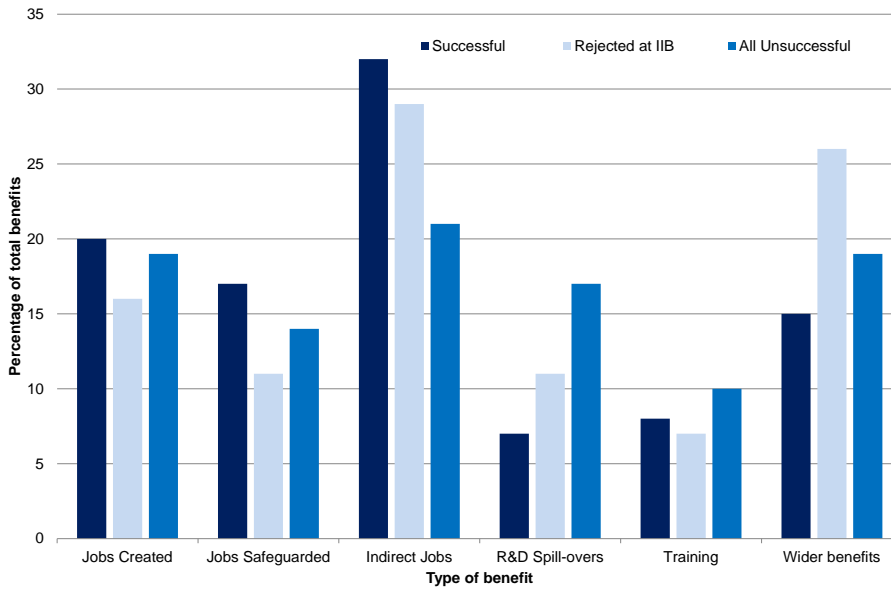
Figure A2: Distribution of AMSCI project expenditure

Source: Analysis of Application forms

Anticipated benefits

Figure A3 shows the decomposition of benefits associated with successful and unsuccessful projects by type of benefit (as measured through the VFM appraisal process). As the figure shows, over one third of the anticipated benefits of successful AMSCI projects were driven by estimates of the indirect employment impacts associated with the bids, and more than 35 percent through job creation and safeguarding effects. Productivity gains through R&D spill-overs and training effects were a relatively small component of the overall benefits involved as measured through the appraisal process (though estimates of wider benefits often incorporated measures such as cost savings driven by energy efficiency gains, which should also be included under the heading of productivity gains).

Figure A3: Distribution of projects by underlying objectives



Source: Analysis of (VFM) appraisal Data

Markets

The applications forms were also used (where possible) to categorise the geographical profile of the main customers of supply chains (i.e. the export orientation of the products involved), and the geographical profile of the competition faced (in terms of ‘domestic,’ ‘international’ or ‘mixed’ markets). The majority of AMSCI projects involving goods being produced for mixed (both domestic and international markets, 83 percent of projects), facing competition from suppliers based internationally (68 percent of projects). This aligns closely with the overall objectives of AMSCI (which in part was created to strengthen supply chains in the face of global competition).

A4 Participants

Table A2 sets out the total number of (gross) participants involved in AMSCI applications (lead applicants and partners) by round. An analysis of application forms suggest that a total of 870 lead applicants and partners were involved in AMSCI applications over the six rounds (an average of 5.1 partners per application). The average number of partners involved in Rounds 3 and 4 tended to be higher than average at 7.0 to 8.0 partners per application.

Table A2: Number of lead applicants and partners to AMSCI by Round

Application	Round 1.1	Round 1.2	Round 2	Round 3	Round 4	WMLCR	Total
Lead applicants	10	22	41	24	51	20	168
Partners	38	22	162	160	319	0	701
Average no. of participants	4.8	2.0	4.9	7.7	7.3	1.0	5.1
Total	48	44	204	184	370	20	870

Source: AMSCI application forms held by Finance Birmingham

There was some overlap in the partners across bids: firstly, in the case of repeat bids, the partners involved are counted in twice in the table above. Additionally, some partners were named in multiple projects. Table A3 gives the distribution of 'unique' partners by applicant type, and success in the application process (partners that were successful at any point have been classified as successful applicants). This analysis suggests:

- **Numbers of unique partners:** There were a total of 247 unique successful partners, a total of 79 partners involved in projects that were unsuccessful at the Independent Investment Board (and 432 partners unsuccessful overall). Again, this suggests that samples sizes of firms may be limited for econometric analysis (particularly if there is interest in focusing only on those applications that made it to the Independent Investment Board). However, the number of observations can be substantially increased if annual measures of the outcomes and control variables can be established (and scope for statistical analysis may be less limited in this regard).
- **Clustering of outcomes:** Effective sample sizes, however, will be substantially reduced if there is significant clustering of outcomes at a project level (i.e. if there is some correlation in the outcomes achieved at a project level, then this will substantially reduce the effective number of observations available for analysis, and statistical power of any econometric analyses).
- **Type of firms:** There was relatively consistent distribution of partners across different types, with SMEs forming the majority of partners involved (around 66 to 75 percent), and large firms forming a large share of the remainder. Close to 50 HEIs were involved in total, alongside smaller numbers of other organisations (such as local authorities and the NHS). The distribution of partners across different types of bid was relatively balanced.

Table A3: Unique partners by organisation type (%s)

Application	Successful	Rejected at Independent Investment Board	All unsuccessful
Large Firm	30 (74)	20 (16)	24 (102)
SME	60 (148)	59 (47)	63 (273)
HEI	8 (19)	4 (3)	6 (27)
RTC	2 (5)	1 (1)	2 (7)
LA	0 (0)	0 (0)	1 (3)
NHS	0 (1)	0 (0)	0 (0)
Unknown	0 (0)	15 (12)	5 (20)
Total	100 (247)	100 (79)	100 (432)

Source: Application forms and minutes of the Independent Investment Board (number of partners provided in brackets)

A5 Primes / Tier One Suppliers

Details of the Primes or Tier One suppliers named within the applications were extracted from successful and unsuccessful applications making it to the Independent Investment Board. It was feasible to identify one or more named Primes or Tier One suppliers in 48 successful applications and 14 unsuccessful applications that made it to the Independent Investment Board. This analysis yielded the following results:

- **Total Primes / Tier One suppliers:** A total of individual 67 Primes or Tier One suppliers were named across the bids examined. Fifty three of these firms were named in just one application across the pool of bids considered. A further 10 were named in two applications, with four further firms named in 3, 6, 7 and 14 applications respectively.
- **Size of potential treatment and comparison groups:** A total of 56 Primes or Tier One suppliers were named in successful applications, and 16 named in unsuccessful applications that made it to the Independent Investment Board. However, there was some overlap between successful or unsuccessful applications: five Primes or Tier One suppliers named in unsuccessful bids were also named in successful applications (giving a potential comparison sample of just eleven Primes or Tier One suppliers).

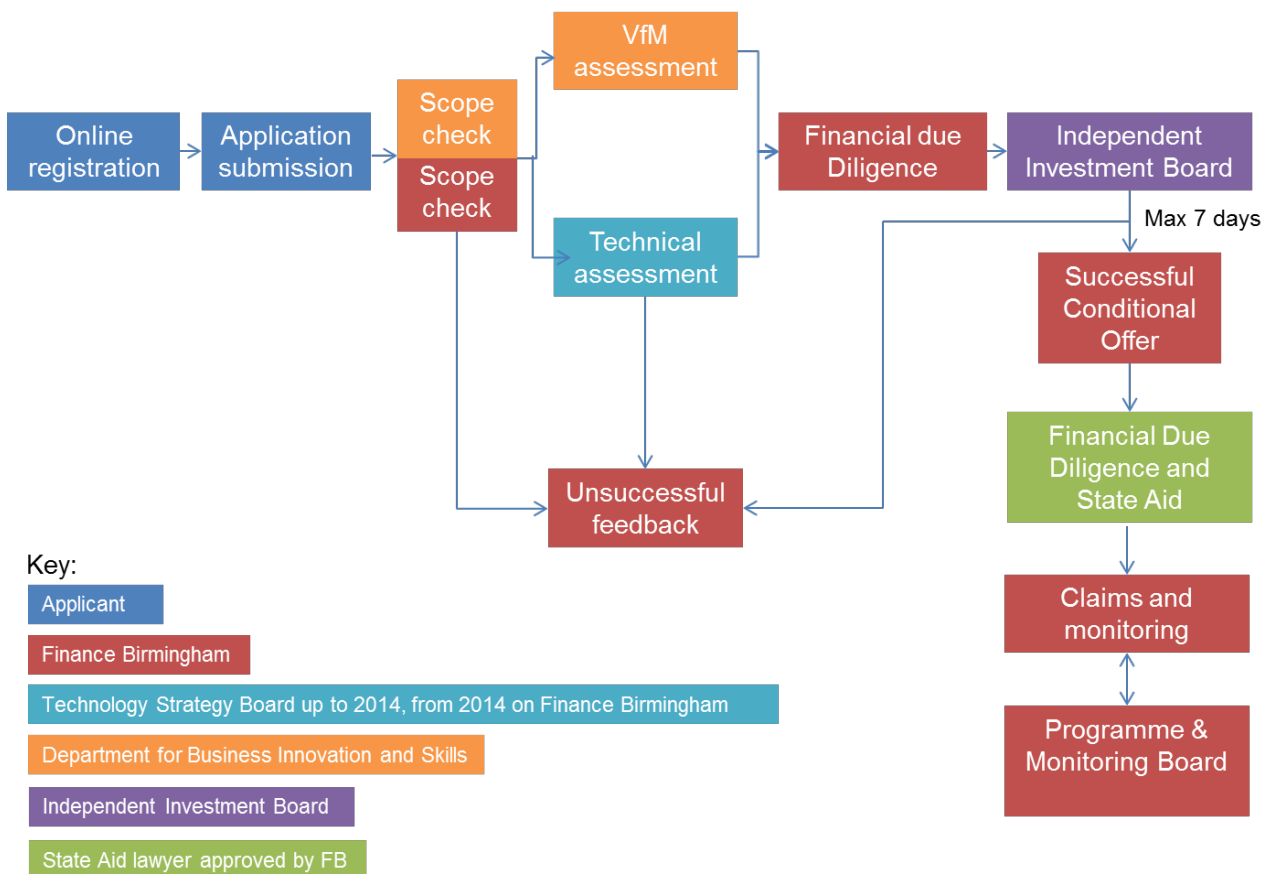
Annex B: Monitoring

This section provides a descriptive outline of the range of monitoring information collected through the delivery of AMSCI, and the processes employed in its collection. Monitoring information is generated at the three key points of AMSCI implementation: through the application process, the appraisal and project selection process, and through the monitoring and delivery of successful projects.

B1.1 Overview

Figure B1 gives an overview of the various stages of the management and administration of the AMSCI programme. Monitoring information is generated at each key stage and collected variously by Finance Birmingham, Innovate UK (formerly the Technology Strategy Board)²¹, and the Department for Business, Innovation and Skills.

Figure B1: Overview of AMSCI administrative processes



²¹ The Innovate UK assessors were not involved in the WMLCR and AMSCI 2014 rounds.

B1.2 Application Data

All applicants to the AMSCI programme submitted a formal application to Innovate UK²². The application form comprises three elements:

- **Application form:** A document prepared by the lead applicant setting out (1) basic details of the project (including project name, type of funding requested (grant or loan), contact details for the lead applicant, project timescales, and sector), (2) a narrative outline of the project proposal and its anticipated impacts, (3) details of how the project will be implemented and associated Governance arrangements, (4) an explanation of the funding involved and justification for requesting public funds, (5) summary of other public sources of finance involved, and (6) details of the range of organisations involved in the collaborative project (including their name, Companies House Reference number, postcode, resources committed to the project, and the level of grant and loan funding requested). The current application form used for AMSCI 2014 is updated to reflect HMT Green Book five stage Business Case model (i.e. strategic case, economic case, commercial case, financial case, and management case).
- **Financial Appendix:** Supplementary financial appendices are prepared for each organisation involved in the project, setting out (1) basic details of the organisation (including named contacts, postal address, sector, employment and turnover), (2) details of other public sector funding sources, and (3) details of how funding will be used (broken down by capital expenditure, training and skills expenditure, research and development expenditure, and other costs). A specific form has been developed for HEIs. It contained information on the applicant's name, name of the academic institution, a table summarising the staff efforts and a table on financial resources (directly incurred, directly allocated, indirect costs and any exceptions).
- **Outputs:** Finally, the application form captures details of the outputs associated with the project proposal overall, including the number of workers to receive training by NVQ level, levels of proposed R&D expenditure by type, and the anticipated number of direct and indirect jobs²³ created.

Each proposal is given an 'application number' upon receipt. Applicants are able to submit supplementary appendices, including the project delivery plan, associated Work Packages to be discussed under the Management Case and letters of support. Alongside the application form, the applicant is required three years statutory (full details, not abridged) accounts for each member of the consortium. The information is held by Finance Birmingham but is not aggregated in any form of central database.

The format of the application form has remained relatively constant over time. In as they both asked the applicant for same applicant information and a detailed description of the proposal (business case) and the financial information related to the proposed project. In the earlier rounds, however, the application form asked information about the 'project' which consisted of the description of the consortium and in the later rounds (3 and 4) there was a request to outline the project management and capabilities to undertake the project.

²² This was not the case for WMLCR and AMSCI 2014 in which Finance Birmingham received applications directly.

²³ Jobs created and job safeguarded are defined as total number of full time equivalent (FTE) direct jobs

One additional change over time was that the round AMSCI 2014 has been designed to be more flexible, with applications assessed and invested in regularly throughout the year, allowing companies to apply when they have fully developed their proposal.

B1.2. Appraisal and Project Selection Data

Further management information is generated through the appraisal and project selection process. All bids received a form of 'technical appraisal' undertaken by a panel of independent assessors contracted by the Innovate UK (or in AMSCI 2014, by Finance Birmingham). Many bids (though not all)²⁴ received a value for money assessment (an HM Treasury Green Book compliant economic appraisal) undertaken by BIS, generating further information on the characteristics of the project involved. In rounds 1 and 2, only those bids that passed the Technical Appraisal, received a VFM assessment.

B1.2.1 Technical Appraisal Data

As noted in the Section 2.2, all applications to AMSCI received a 'technical appraisal' from a panel of five independent assessors (this will remain the same in AMSCI 2014 and will comprise of 3 assessors with sector specific knowledge and two retained assessors who work across all applications). Assessors were asked to give each proposal a narrative judgement and a score from 1 to 10 against the questions set out in Table B1 (which changed between Rounds 2 and 3 of AMSCI, and applicants to the West Midlands / Liverpool City Region²⁵ (WMLCR) programme were judged against a subset of seven of the nine questions).

The total score associated with a proposal was the sum of the average scores received across the assessors involved. Assessors were also asked to make an assessment of whether the project was within the scope of the overall objectives of AMSCI, and whether they recommended the bid for funding. Scores were used to give proposals 'green,' 'amber' or 'red' status based on pre-agreed thresholds (though these changed from round to round as the applicants total score changed with the number of applications).

A second metric labelled 'spread' was derived from the scores, described the sum of differences between the highest and lowest scores received in relation to each question. Where the 'spread' was high (indicative of disagreement amongst the panel), applications entered a moderation process in which the scores were reappraised by further set of independent assessors.

²⁴ Round 1.2 and WMLCR did not receive VFM assessments. This was due to the lower value of subsidies on offer, and the programmes were funded through the Regional Growth Fund (and as such, a VFM appraisal had been undertaken by the RGF Secretariat at the level of the programme overall).

²⁵ This part of AMSCI focuses on single firm interventions and is targeted at the West Midlands and Liverpool City Region LEP areas. In this case, the technical appraisals were completed by TSB assessors contracted directly by Finance Birmingham.

Table B1: Questions raised from the Technical Appraisal

No.	WMLCR	Round 1 and Round 2	Rounds 3 and 4
1.	What are the commercial opportunities that this project proposal opens up for the applicant(s) and its supply chain?		
2.	How will the project proposal address the development of your business and its supply chain?		How will the project proposal address the problems affecting the development of your business and its supply chain?
3.	How will the project proposal lead to new job creation or safeguard existing jobs?		How does your project demonstrate vision and impact?
4.	What other wider economic, social and environmental benefits, is the project expected to deliver to those inside and outside of the supply chain and over what timescale?		What is innovative about this project?
5.	How does your project demonstrate vision, innovation and impact?		What is the proposed investment in the project for R&D, capital and skills and training?
6.	How will the project be managed taking account of the known risks to ensure successful delivery?		How does financial support from this fund add value?
7.	Does the applicant(s) have the right skills and experience and access to facilities to deliver the identified benefits?		How will the project proposal lead to new job creation or safeguard existing jobs?
8.		What is the level of funding commitment that is required for the project?	What other wider economic, social and environmental benefits is the project expected to deliver, to those inside and outside of the supply chain and over what timescale?
9.		How does financial support from this fund add value?	What are the risks (technical, commercial and environmental) to project success and how will they be managed to ensure successful project delivery?
10.			What is the project plan and does the project team have the right skills and experience and access to facilities to deliver the identified benefits?

Datasets

The monitoring data generated through the technical appraisal process is collated in datasets named 'panel sheets'²⁶ which have been constructed for each round except the WMLCR programme. These panel sheets provide both the scores received by each assessor against each question for each application subject to appraisal, and a summary sheet providing aggregate information. The information collected in these datasets evolved over the rounds reflecting changes in the appraisal process as set out in Table B2.

²⁶ Panel sheets excluded the WMLCR round for which appraisals were held only in word format for each bid individually.

The summary panel sheets contain a range of key data on (a) projects and (b) rankings.

- **Project level information** consists of the project number, project title, lead organisation, lead name, lead email, duration, number of partners, project cost, total public funding, running total, indication on pre-industrial/industrial, loan sought and grant sought);
- **Information on ranks and scores** including the average score received across the five assessors, the spread of scores given, average scores with outliers removed, the projects ranking across the bids received, and the number of assessors judging the project in scope and recommending the project.

The range of information captured within the panel sheets varies from round to round as described in the table.

Table B2: Information in the panel sheets

Field	Round 1 Stream 1	Round 1 Stream 2	Round 2	Round 3	Round 4
Project number	x	x	x	x	x
Project title	x	x	x	x	x
Category (sector)	x	x	x	x	x
Lead Name				x	
Email address for lead applicant	x	x	x	x	x
Duration of project (months)			x	x	x
No. of partners involved			x	x	x
Order of Moderation					x
VfM score				x	x
Average appraisal score	x	x	x	x	x
Spread of assessors scores	x	x	x	x	x
Score if outliers removed					x
Ranking			x		x
Number of assessments returned	x	x	x	x	x
Number of assessors judging project is in scope	x	x	x	x	x
Number of assessors recommending the bid	x	x	x	x	x
Project cost	x	x	x	x	x
Grant sought			x	x	
Loan sought			x	x	
Total public funding involved	x	x			x

Field	Round 1 Stream 1	Round 1 Stream 2	Round 2	Round 3	Round 4
Running total (cumulative funding requested)	x	x	x	x	x
TSB Decision	x	x		x	x
Industrial/Pre-industrial				x	
TSB Line draw outcome				x	

B1.2.2 VFM assessment

Proposals submitted to Round 1 Stream 1, Round 2, 3 and 4 were subject to a value for money appraisal by BIS staff. In Round 1 Stream 1 and Round 2, only those passing the technical appraisal received a value for money appraisal. All bids received under Rounds 3 and 4 received a VFM assessment. Proposals submitted to Rounds 1 Stream 2 and to the West Midlands Liverpool City Region did not receive a VFM appraisal.

The value for money appraisal generates a range of further measures of project characteristics as summarised in Table B3.

Table B3: Individual VFM assessment measures

Measure covered by the VFM appraisal	Description of the measure and process
Project aims and objectives	A reproduction of the TSB's description of the project adding, if appropriate, a narrative assessment of: the measurable impact on competitiveness and economic growth, the scale and complexity of the project and how it will have a genuine impact on competitiveness, the contribution the project will make to innovation and technology development (including low carbon benefits), the project's ability to increase UK manufacturing capacity, capability and efficiency, the project's ability to raise skill levels or close skills gaps, the positive economic and employment benefits, which support rebalancing the economy and growth.
Assessment of commercial opportunity	A further narrative assessment of short assessment of the new or existing market or business opportunities that could be gained and by whom (again reproducing elements of the technical appraisal).
Market failures addressed	A short assessment of the particular market failures which would be addressed by the project.
Additionality	A short assessment of deadweight - the impact that government support will have relative to a counterfactual scenario in which it is not offered. A quantitative score is given between 0 and 100 percent (with 100 percent representing full additionality and zero representing full deadweight).
Displacement, substitution and leakage effects	A consideration the degree of likely effects in secondary markets covering (1) displacement in factor markets, (2) displacement in product markets, and (3) substitution effects. A measure of net displacement is calculated using the standard formula (i.e. gross additionality x (1 – displacement) x (1 – substitution) x (1 – leakage))
Project Risk	A brief assessment of the risks associated with this project which may impact on the expected outputs and the steps which will be taken to mitigate them. A quantitative risk factor was also applied (where 0 is indicative of negligible risk and 100 very high risk). This is capped at 50%.
Employment Impacts (Direct and indirect)	Both direct created jobs and safeguarded (existing jobs which would be lost if this project did not go forward) jobs are recorded, with estimates of the present value of associated benefits estimated on the basis of the wages at different salary bands and NVQ levels. Indirect employment impacts are estimated separately using a similar approach (in Rounds 1 and 2, indirect jobs created and safeguarded were separated, while in Round 3 and 4 these two measures were combined).

Measure covered by the VfM appraisal	Description of the measure and process
Skills and Training	Skills and training GVA Impacts are estimated on the basis of expected (lifetime) salary uplifts associated with movement up NVQ levels and the number of individuals receiving training. Benefits are only included if training involves a qualification at NVQ level 3 or above (adjustments are not made for expected completion and achievement rates).
Research and Development	The present value of R&D spill-over benefits are driven by levels of R&D expenditure associated with the project and are driven estimates of the social return on R&D expenditure derived from secondary literature. In Rounds 1 and 2, these estimates were driven by annual spend on R&D, though in Rounds 3 and 4, the R&D stock was allowed to accumulate over time (with depreciation rates based on OECD research).
Wider economic benefits	Wider economic benefits were integrated directly into the appraisal if they could be monetised. In practice, these largely focused on either productivity gains (cost savings), or the reduction in negative externalities associated with any CO ₂ savings (a particular focus for any projects involving substantial energy efficiency gains).
Project cost	Total project cost is defined as a combination of the funding from non-government sources and cost to government (grant, loan or a combination of the two).
Non-monetised benefits	Appraisers were finally asked to provide a judgement of the level of non-monetised benefits associated with proposals (low, medium or high).

The final cost-benefit score is calculated as a ratio of total opportunity cost to the government (sum of opportunity cost of the grant and the loan) and the total benefits (employment, skills and training, R&D spillovers and wider benefits adjusted for additionality and project risks).

The VfM assessments are collected and stored in folders organised under projects within each round, along with the feedback and any evidence about associated discussions. In a few of cases, more than one version of the VFM spreadsheet existed where the proposal has been re-assessed after clarifications from the bidder.

B1.2.3 Project Selection Decisions

All applications that received a 'green' assessment through the technical and (where applicable) the VFM appraisal were submitted to the Independent Investment Board for the final decisions on project selection. Details of this process are only collated in the minutes of the Independent Investment Board, which tabulates the order in which each proposal is discussed and the decision reached by the panel. Projects are referenced only by their project title. Several applicants were asked to resubmit following feedback on their initial applications (on the expectation that the application would improve following a resubmission). However, this makes it difficult to trace the decisions of the IIB in some cases where applications for projects with the same name have been submitted in more than one round.

B1.3 Monitoring Data

This section describes the monitoring information captured over the lifetime of an AMSCI project and the processes employed to capture the information involved.

B1.3.1 Monitoring Indicators

The monitoring of deliverables through the AMSCI programme is limited to a relative narrow set of monitoring indicators:

- **Expenditure:** Projects are monitored on a quarterly basis in terms of their total expenditure²⁷ and drawdown of AMSCI grant funding as part of the monitoring cycle.
- **Jobs created or safeguarded:** Projects are also monitored on the basis of the number of jobs created and safeguarded (again as part of the quarterly monitoring process). Jobs safeguarded are defined as jobs at threat of being lost within 12 months.

These quantitative measures are monitored at a partner (rather than a project) level. Job outputs form part of the contractual agreement and material changes must be reviewed with BIS (reviewed in relation to VFM) and escalated to the Independent Investment Board if necessary.

Alongside these quantitative metrics, progress is also monitored through narrative progress updates (structured against the different 'Work Packages' of activity defining the milestones and timescales associated with each discrete element of AMSCI projects), as well as through the production of the 'collaboration agreement' that defines the roles and responsibilities of consortium members and how the benefits of the project will be shared amongst the partners concerned. Monitoring is undertaken both at the partner and project level.

B1.3.2 Monitoring Process

Each successful applicant is required to comply with a range of monitoring obligations set out in the conditional and final Grant Offer Letters. AMSCI involves both a project contracting and start-up process, and a subsequent quarterly monitoring cycle, in which grant expenditure is paid against claimed defrayal and outputs delivered:

- **Responsibilities:** Overall responsibility for co-ordinating the collection and submission of monitoring information across each consortium lies with the lead applicant. The lead applicant is responsible for gathering information on progress from each partner involved and submitting this evidence to Finance Birmingham. However, payments of grant funding are paid directly by Birmingham City Council (upon approval by Finance Birmingham) to each partner (rather than cascaded across the partners involved by the lead applicant).
- **Project planning:** As part of the contracting and due diligence process, the lead applicant associated with each project will prepare a variety of project management documents, including 'Work Package' plans, detailed risk register and Gantt charts describing the key milestones and timings associated with each package of activity being funded through the AMSCI project, and a collaboration agreement defining how the collaborative project will be managed, the roles and responsibilities of respective partners, and how any intellectual property or other benefits of the project will be shared

²⁷ Broken down by labour, overheads, materials, capital equipment, subcontractor payments, training, test equipment, and other expenditure items.

amongst partners (which is kept on file by Finance Birmingham). A suggested template for the 'Work Package' plans is provided in the conditional Grant Offer Letter, though lead applicants are free to use a format that suits them provided it has been developed to the satisfaction of the relevant Monitoring Officer concerned.

- **Quarterly monitoring cycle:** Following the completion of due diligence, a confirmation letter is issued and the project enters a quarterly monitoring process in which the lead applicant submits claim for grant funding. This involves submission of a narrative assessment of progress and results against the Work Packages agreed through contracting, the completion of a quarterly claims form (detailing expenditure on the project broken down by type, and the number of jobs created and safeguarded), and supplementary evidence to validate the claim.
- **Evidence requirements:** Claims made for capital expenditure on equipment and tooling must be evidenced by supporting invoices as part of quarterly submissions. Labour costs need to be evidenced by time sheets. This evidence is used by Monitoring Officers to validate the quarterly claims and authorise payments. Jobs created are verified by examining changes in total employment on the sites concerned.
- **Site visits:** Monitoring Officers also have an option of a quarterly visit and generally time these with the claim submissions so details can be verified on site. Monitoring Officers often attend project meetings to allow for them to get a better overview of the progress as well as understanding the working relationships of the consortia.
- **Annual audit:** Lead applicants must also submit an annual audit report completed by independent accountant (the terms of which are defined the final Grant Offer Letter). The annual audit does not fully review jobs but there is a contractual obligation for firms to share job data if requested. These reports require the accountant to certify that the expenditure claimed in over the course of four quarters have been defrayed in connection with the project by the lead applicant and the partners involved.
- **Changes in consortium membership:** On some occasions, there will be changes in consortium membership (for example, if a partner pulls out due to changes in ownership). This will require a contract variation and a new Grant Offer Letter.
- **Risk:** Risk is monitored on a project by project basis through the continuous updating of a risk register. The risk register is initially based on the risks identified through the appraisal process, with further risks added to or removed from the register on an on-going basis. These risks feed into aggregate performance management, with each project assigned a RAG status (red, amber or green risks) for review at regular programme board meetings.

B1.3.3 Monitoring Control Sheet

Monitoring information is captured in a database named the 'Monitoring Control Sheet' or MCS. This describes the performance of each project in terms of total expenditure defrayed (against the budgeted profile) and jobs created and safeguarded, alongside the RAG status of projects. Monitoring information is broken down by partner (though only for current partners). The MCS does not store all information captured through the monitoring process (for example, only total expenditure and grant-draw down is captured).

B1.4 Summary

- **Range of data gathered:** AMSCI delivery processes capture a wide range of monitoring information relating to the projects proposed by applicants and details of the partners concerned. This includes the scores given to projects as part of the technical and value for money appraisals, project selection decisions, and monitoring of the progress made by projects.
- **Homogeneity of appraisal data:** Appraisal processes have varied from Round to Round, with changes in (1) the nature of the technical appraisal, (2) scope of the VFM assessment, and (3) methodology for the VFM assessment. This will need to be borne in mind in any efforts to match successful to unsuccessful applicants on the basis of appraisal scores.
- **Diversity of sources:** The monitoring information is collected and stored separately by different partners involved in the delivery of AMSCI (including Finance Birmingham, the Innovate UK, and the Department for Business, Innovation and Skills). Not all of this data is captured in central systems or databases (such as the components making up VFM scores or detailed breakdowns of financial expenditure associated with projects).
- **Limited range of monitoring indicators:** AMSCI projects are monitored against a narrow set of monitoring indicators covering the expenditure associated with projects and the number of jobs created or safeguarded. Monitoring is limited to those aspects connected directly with the projects (with no firm level monitoring).
- **Documentary evidence:** There is a range of supplementary documentary evidence captured through monitoring that may be of use for future evaluation of the AMSCI programme, including quarterly narrative assessments of progress made against the Work Packages agreed with applicants.

B2 Monitoring Data Assessment

This section provides an assessment of the quality of the monitoring information against the following criteria: (1) its comprehensiveness (for the purposes of performance management and evaluation), (2) its completeness, and (3) the robustness of both the processes used to collect the data and the data itself. This section explores a range of issues identified in completing this assessment, and makes recommendations for enhancing the monitoring processes involved.

B2.1 Scope of Monitoring Indicators

As suggested in the preceding section, the range of monitoring indicators captured through the monitoring process is relatively narrow (limited to the expenditure associated with the project, and the number of jobs created or safeguarded). A logic model is set out overleaf, describing the anticipated causal process by which AMSCI projects will deliver their anticipated outputs, outcomes and results (with those elements that are currently monitored marked out on the diagram). While monitoring captures the key resources consumed in the delivery of projects, there is scope for projects to deliver a much broader range of outputs than currently monitored:

- **Collaboration:** Although the characteristics of the collaboration are monitored in the form of the Collaboration Agreement (kept on file by Finance Birmingham), no quantitative measures of the characteristics of the collaborative arrangements are monitored systematically over time. Given the importance of collaboration to the majority of AMSCI projects (i.e. excluding those single firm interventions funded through the WMLCR programme and Round 1.2), it may be beneficial to capture quantitative metrics relating to the collaboration itself. It is typically challenging to define clear quantitative metrics in relation to collaborative industrial projects²⁸ as public initiatives are often not prescriptive on the desired form that collaboration should take or its expected outcomes (and this is equally the case with regard to AMSCI). However, three key elements relating to the collaboration could potentially be used to supplement existing indicators:
 - **Novelty:** The AMSCI Business Case stresses that the programme aims to foster collaborative activity between firms that have not worked on a co-operative basis previously. As such, a measure of the number of partners that have developed new collaborative relationships through AMSCI may help illustrate how far these goals have been realised. Such a measure would not necessarily be dynamic (requiring refreshment only when partners changed), with the necessary information collected through adjustments to the application form.
 - **Stability:** Secondly, the literature review undertaken to support the development of scoping studies suggested that market failures can cause some forms of collaboration to be inherently unstable (owing in particular to the incentive of firms to free-ride on others' investments). A measure of the stability of the partnerships

²⁸ For example, a 2011 Evaluation of the Collaborative Research and Development Programmes by the Innovate UK highlights that the management information is limited to the scope of the collaboration (i.e. number of academic and commercial partners, the size of the grant, and total project costs).

formed could be assembled from existing monitoring information (e.g. the percentage of firms named in application forms still involved in the collaboration), and though this would not necessarily be a measure of performance, it would provide helpful insight into how far such issues represent a material issue for AMSCI projects.

- **Dynamism:** There may also be benefits in monitoring the dynamism of collaborations (whether the number of partners grows over time or how far the collaboration degenerates through on-going loss of partners). Again, this can be compiled straightforwardly from existing monitoring information.

Issue for consideration: monitoring of collaboration

The policy could have been potentially designed more prescriptively by specifying the type and form of collaboration that was desired in the business case, which would have in turn made it more straightforward to define KPIs for collaboration. However, such prescription should only be applied if there are strong ex-ante expectations that certain forms of collaboration are likely to prove more effective, and it is less than clear that there is sufficiently strong evidence to make such a case in the context of AMSCI.

- **Training outputs:** Although monitoring information captures expenditures incurred by partners in the delivery of training, there are no quantitative metrics currently captured on the number of workers receiving training and subsequently gaining qualifications. This is a key measure driving the VFM appraisal, and although training is not typically a central component of AMSCI projects it would be beneficial to integrate measures of these deliverables into Grant Offer Letters to verify that training expenditures made are leading to their anticipated outputs.
- **R&D outputs:** The monitoring framework currently does not capture any of the results associated with R&D activity (other than any jobs created). The results of R&D activity might be captured in the volume of patents registered (though there may be limited value in monitoring this as a measure of performance, as many patents are registered solely as a defensive tactic), but its value will be loaded into any capitalisation of the IP rights. The annual audit process could potentially facilitate the on-going monitoring of the value of IP generated through (as the Independent Accountant could validate any measures reported by applicants). However, it is important to acknowledge that the value of IP may also be a flawed measure: if patents can be easily broken, which would dampen the overall value of IP generated through projects, while accountants may take a conservative view on the likely emergence of competitor technologies by heavily discounting future profits.
- **Technical Progress:** Technical progress could be measured through the TRL and MRL scales, and/or the introduction of new processes or products. It should be noted however that ideally, the monitoring data would include baseline values for TRL / MRL levels to measure progress, which have not been collected.
- **Jobs created and safeguarded:** The current monitoring framework does not distinguish between R&D and non-R&D jobs created (that might be considered as inputs to the projects concerned) and jobs associated with the expansion of production

(outcomes of the projects). It would be beneficial if these two types of jobs could be separated in monitoring, as combining these two measures could give misleading interpretations over the results of the projects concerned.

- **Productivity and energy efficiency gains:** AMSCI projects are expected to lead to a range of productivity and energy efficiency gains which are not currently monitored. While in principle, it would be possible to measure and attribute changes in GVA per worker (though not total factor productivity) and energy efficiency directly to the results of AMSCI projects, the complexities involved (including validating any reported results) are likely to be intractable. It is suggested that these measures are addressed through evaluation rather than monitoring (though collection of firm level data to support an evaluation would be beneficial as described in the following section).

B2.2 Approach to monitoring

The monitoring of AMSCI focuses almost exclusively on the resources absorbed and results associated with the projects funded. However, the majority of quasi-experimental impact evaluation strategies rely on observations of the outcomes of interest at a firm level (i.e. total employment, rather than jobs created in connection with the project), and one of the major challenges involved is in establishing reliable longitudinal measures of these outcomes. The monitoring process could be potentially be leveraged to substantially address some of these challenges:

- **Application forms:** Appendix B of the application form currently asks applicants to report turnover and employment levels at the point of application. This could be adjusted to require applicants to provide longitudinal records of these and other outcomes (see Table B4) over a three to five year period running up to the application²⁹ for each participant. The data presented in applications could then be validated in due diligence.
- **On-going monitoring:** Updates to such firm level metrics could then be integrated into annual monitoring processes for successful applicants (through an extension of the scope of the annual audit report, for example).

While it may be too late to make such adjustments for AMSCI rounds that have passed, it is suggested that these amendments are given consideration for future rounds (contingent on the outcome of the Impact and Economic Evaluation Scoping Studies), as they limit the challenges associated with quantitative data collection to establishing appropriate longitudinal measures of the outcomes concerned to the comparison group.

There are also issues to consider around the level at which these indicators might be monitored. In the case of large firms, they may use the subsidies to displace activity that may have otherwise taken place at another location, and it is suggested that these indicators are monitored at the level of the enterprise rather than the site concerned. There

²⁹ Though to ensure that the outcomes of interest are measured from the same point in time, this period would ideally be lengthened each year if multiple AMSCI rounds were to be considered together. Collecting only 'before and after' data for each firm may be an alternative, though differences in the timing of rounds may mean that results are biased by broader changes in economic conditions (which will be more difficult to control for without longitudinal data).

may be broader issues in the case of firms that form part of larger enterprise group (in which case the parent company may have chosen to take the project forward through a different subsidiary). It is suggested that such issues are investigated through analysis of secondary data (for example, it is possible to aggregate BSD data to the enterprise group within the Virtual Microdata Laboratory) rather through monitoring. Table B4 refers only to those additional measures that would be useful to capture at a firm level for the purposes of a main-stage evaluation.

Table B4: Firm Level Measures Ideally Captured Through Monitoring

Outcome area	Firm level metrics
Resources consumed	<ul style="list-style-type: none"> • Total net capital investment (£s) • Research and development expenditure (£s) • Training expenditure (£s)
Output	<ul style="list-style-type: none"> • Total wage expenditures (£s); • Total profits (£s);
Assets	<ul style="list-style-type: none"> • Total value of intangible assets (£s);
Other metrics	<ul style="list-style-type: none"> • Total employment (FTEs) • Total export sales (£s) • Total gas consumption (MWh) • Total electricity consumption (MWh)

B2.3 Applicant Details

As suggested above, in order to undertake any impact evaluation of AMSCI, it will be necessary to collect information on the outcomes of interest at a firm level. The availability of details of applicants is critical for the viability of any impact evaluation, as without them, no data-linking or surveys to collect these observations will be possible.

The application form and its appendices in particular are well designed for the purposes of evaluation. In principle, these processes collect named contact details for each partner involved in the project (including postal addresses, telephone numbers and email addresses), as well as Companies House Reference numbers (which is helpful in facilitating data-linking to administrative datasets). However, a review of the application forms (as well as the process of assembling the sample for the parallel survey taking place as part of the process evaluation) highlighted a range of issues with the comprehensiveness and accuracy of this data:

- **Incomplete application forms:** A number of applications were incomplete in that the scope of the financial appendices supplied in the application did not reconcile with the table of partners specified in the panel sheets (an issue for 13 applications from 168). The main issue encountered was that financial appendices appeared to be missing for a number of partners named in the application. As these appendices provide critical information on the details of the firms involved in the collaboration, the absence of these forms imposes a significant constraint on what may be feasible in terms of data collection and the robustness of any future analysis.

- **Missing contact details:** There were also substantial issues associated with missing contact details: named contact details were unavailable for 173 partners (701 partners in total) involved in application forms.³⁰
- **Valid CRNs:** The CRNs are not always in the correct 8 character format. In total, amongst those partners for which a CRN was provided, 20 percent were provided in an invalid format. This issue was primarily associated with the omission of leading '0's, which is straightforwardly corrected (or validated through an independent process, as they do in RGF).

These issues primarily relate to the validation of the information submitted in application forms. To improve the quality of data captured through the application process, it may be beneficial to consider the introduction of a process by which the completeness and consistency of the application form is reviewed on submission, and offering the applicant an opportunity to rectify any issues identified over an acceptable timescale (with the potential penalty that the application form would not be considered at appraisal if these details are not submitted).

B2.4 Data Capture

While all relevant details associated with application, appraisal, project selection, and monitoring processes have been captured and stored by the relevant parties, there is no central system for managing these records. This has led to substantial resources³¹ invested (as part of this project) in assembling these details in a single database for the purposes of this project (and as no single organisation is responsible for all data generated). The maintenance³² of a central database describing the passage of each project (and associated partners) through the application, appraisal, project selection, and delivery process would simplify the process of undertaking a future impact evaluation of AMSCI (potentially building on the database constructed as part of this project).

B2.5 Details of Primes

The impacts of AMSCI can potentially be understood by investigating the performance of Primes or Tier One suppliers associated with AMSCI projects (and an appropriate counterfactual). For example, an assessment of the impact of AMSCI on the proportion of finished goods and services consumed by Primes that are satisfied by imports would provide a helpful indicator of the expansion in domestic demand attributable to the scheme that is net of any displacement effects (explained in more detail in Section 6).

Details of the Primes or Tier One suppliers are not systematically captured within application forms, though they are routinely named within the narrative associated with the project description or in letters of support provided with the application form. As such, it

³⁰ Finance Birmingham did not receive applications if they did not progress from Innovate UK. This information may need to be collected sooner in the process, or all applications should be forwarded to Finance Birmingham.

³¹ Data was collected manually from all application documents, but if forms are standardised then macros can be used to extract what is needed. The implications for this were significant (in relation to hours spent on the task).

³² The ongoing maintenance of the data would need very little time resource – particularly if automated processes are used (i.e. macros).

has been possible to identify the Primes or Tier One suppliers associated with 48 successful applications, and 14 unsuccessful applications that were considered at the Investment Board. Adjusting the application form to include a mandatory field or fields in which these details are provided would systematise their collection, and provide a more robust set of data upon which to base any impact evaluation.

B2.6 Robustness of Monitoring Information

The processes adopted to collect monitoring information are robust with regard to the measurement of expenditure in relation to AMSCI projects. The process of independent validation of project expenditure provides substantial assurance that expenditure is being defrayed as claimed. While this process is robust (and mirrors procedures employed in the delivery of the RGF), random (internally led) secondary checks on the invoices and accounts covered within the scope of the annual audit report could provide additional assurance of the certification of the independent accountant.

However, validation procedures could potentially be strengthened with regard to the monitoring of jobs created or safeguarded:

- **Job creation effects** are validated by comparing reported jobs created to the change in total employment observed at the sites being monitored. As such, applicants may be able to claim jobs created that are not connected with the project (for example, if they open a new production line that has not been subsidised through AMSCI). Validation procedures could be strengthened by requiring the applicants to submit job descriptions alongside payroll records and compare these to the job roles defined at the application stage, to provide additional assurance that the jobs reported are connected with the AMSCI project.
- **Jobs safeguarded:** The validation of the jobs safeguarded is relatively light touch, with applicants required to provide a letter (signed by the CEO) that the jobs claimed would have been under threat of redundancy in the next 12 months. Again, stronger evidence in support of these claims might be obtained from Board minutes or papers prior to the submission of the application for AMSCI funding that indicate a high degree of likelihood that the jobs concerned would be lost (for example, the RGF requires that firms prove that jobs have been declared as 'at risk' by the company board within a 6 month period of the application).
- **Annual audit:** Validation of job outcomes does not form part of the annual audit, and again, an extension of the scope of the audit to cover these elements could potentially strengthen the quality of monitoring information gathered through delivery processes. The letter of confirmation regarding jobs also certifies that employment records are available to confirm jobs by audit if required.

B2.7 Key Recommendations

Issue	Recommendation	Resource Implications
<p>The scope of monitoring indicators is narrow relative to the range of potential results that might be achieved by AMSCI projects.</p>	<p>Introduce additional monitoring indicators capturing:</p> <ul style="list-style-type: none"> • Collaboration (new collaborators, and stability of collaborative arrangements) • Training outputs (number of workers receiving training) • R&D outcomes (value of IP generated through AMSCI projects) • Technical Progress 	<p>It is anticipated that the additional resources required to monitor these additional impact will be in most cases limited. Collaboration can be monitored from existing data, while training outputs should be straightforward for partners to monitor.</p> <p>R&D outcomes may be more difficult to monitor. The value of IP generated through AMSCI could be monitoring through the annual audit process (though this would potentially require changes to the Grant Offer Letter). If the scope of the annual audit process increases, this may also confer additional costs onto successful applicants at the margins.</p> <p>Technical progress could potentially be monitored by adapting the narrative progress reports that are currently in use. However, the key difficulty will be obtaining baseline measures against which this progress can be monitored.</p>
<p>R&D and construction jobs (project inputs) are combined with on-going increases in employment associated with production (project outcomes)</p>	<p>Separate construction, R&D, and on-going jobs created and safeguarded in monitoring of these KPIs.</p>	<p>The separation of R&D jobs and on-going jobs would require a change to the Grant Offer Letter. As such, this may be considered a lower priority measure (as such issues can potentially be handled through the evaluation).</p>
<p>Monitoring does not capture the firm level measures of the outcomes of interest that would be used in an impact evaluation.</p>	<p>Adapt application forms and monitoring processes to capture longitudinal measures of the outcomes defined in Table B4, and use the due diligence and annual monitoring process to collect the data needed.</p>	<p>The implementation of this recommendation would involve an increase in the scope of the due diligence and annual monitoring processes that could lead additional costs for applicants. However, the measures required should be available in company accounts, and relatively straightforward for an independent accountant to collect. Collection of these additional measures from existing applicants will also require an adjustment to existing Grant Offer Letters (which may involve additional costs for BIS or Finance Birmingham, as well as reputational risk).</p>
<p>Details of the partners named in project applications are often incomplete, inconsistent, or invalid, raising difficulties in</p>	<p>Adapt processes to review the validity of the partner details submitted as part of applications at the point of submission (for example as part of the initial sift), and offer applicants an opportunity to rectify the issues</p>	<p>Given the comparatively small volumes of applications received, and the general high quality of the contact details supplied, it is anticipated that implementation of this recommendation would only imply a small increase in resources (in the form of staff time).</p>

Issue	Recommendation	Resource Implications
<p>identifying the full range of beneficiary and non-beneficiary firms for the purposes of data collection as part of an evaluation.</p>	<p>identified prior to appraisal.</p> <p>Collect additional registration numbers (VAT and PAYE) to improve the potential for data-linking if CRN numbers are invalid.</p>	
<p>Data is captured across a number any separate systems, with substantial resources required to assemble a central and consistent record of the passage of proposals through the application, appraisal and delivery process.</p>	<p>Maintain the database constructed through this project and make it available to any main-stage evaluation contractor commissioned.</p>	<p>Maintenance of the database constructed for this project would require a small increase in staff resources as it is a comparatively simple Excel spreadsheet.</p> <p>A single organisation would need to be tasked with the responsibility for this process, which would involve adding the scores from the technical and VFM appraisals associated with applications from new application rounds, recording the outcome of the IIB decisions. Monitoring information associated with delivery is already kept up to date through the Monitoring Control Sheet.</p>
<p>Details of the Primes or Tier One suppliers associated with AMSCI projects are only available through the narrative descriptions of projects or from letters of support, making it difficult to robustly construct a treatment / counterfactual sample for the purposes of impact evaluation.</p>	<p>Add a field to future application forms to ensure that these details are captured on a consistent and systematic basis in future rounds of AMSCI.</p>	<p>The resource implications of this recommendation will be minimal.</p>
<p>Validation of job outcomes (particularly jobs safeguarded) do not always provide strong assurances that the jobs claimed can be attributed to the AMSCI projects.</p>	<p>Extend the scope of the annual audit to include validation that the reported job outcomes can be reasonably attributed to the AMSCI project.</p>	<p>The implementation of this recommendation would potentially require changes to the Grant Offer Letter (and the associated costs involved). If the scope of the annual audit process increases, this may also confer additional costs onto successful applicants.</p>

Annex C: Wider Datasets

This section provides an outline of the wider secondary datasets that could be exploited in an evaluation of AMSCI.

C1 Patent Data

Records of beneficiary firms can be linked to European Patent Office data to provide a range of measures that may be useful to explore in the impact evaluation:

- **Joint patent registrations:** EPO data captures the joint registration of patents, which could be utilised to provide a proxy measure of collaboration (and examine how far AMSCI has led to an increase in the level of collaboration amongst beneficiary firms).
- **Patenting activity:** There may be interest in exploring levels of patenting activity (as a measure of R&D output): i.e. the probability of registering a patent, or the number of patents registered. Such a measure would not provide a useful measure of the economic value of AMSCI as many patents may have no intrinsic value if they have been used to block competitors exploring similar R&D targets. However, it may provide a useful measure of how far the R&D effort has intensified as a consequence of AMSCI subsidies (particularly if there are difficulties in obtaining measures of R&D expenditure).
- **Patent citations:** EPO data also records the citations of prior patents in the patents registered by other firms. This would provide a proxy measure of both the quality of the patents registered by AMSCI firms, as well as a partial measure of the presence of any R&D spill-over effects that may have been generated.

EPO data could also be examined in more detail to provide qualitative detail of the technical progress being made by AMSCI beneficiaries. The data could also be used to explore the character of any R&D spill-overs (by providing an analysis both of how other firms have built on the patents registered by AMSCI beneficiaries, and the industrial distribution of firms citing patents registered as a consequence of AMSCI). However, to exploit this opportunity, more information will need to be collected through monitoring of the patent numbers registered by AMSCI beneficiaries in connection with the project to allow their identification in the AMSCI dataset.

C2 Meter Point Data

The Department for Energy and Climate Change statistics were engaged as part of this study to determine the possible use of Meter Point Data currently being collected by DECC as part of the National Energy Efficiency Data-Framework NEED. This is a new source of data only now being exploited by researchers and government teams that could potentially offer insight into the energy efficiency impacts of the scheme (a benefit that was often reported by applicants and appraised under the category of 'wider benefits').

Each electricity and gas meter in the UK is registered for billing purposes and the output has been stored by DECC since 2005. The dataset excludes energy usage for only the

top 2 percent of energy consumers: mainly large individual industrial units who purchase energy direct from power plants. There are 30 million electricity and 23 million gas meters in the dataset. Meters are identified only by their unique reference number which is then matched to the Ordnance Survey unique postal reference number (UPRN). There are several types of meters, depending on energy usage levels, and the dataset captures total energy consumed (in kWh) at each meter over a 12 month period.

The data are compiled annually by an external organisation. Gas meter values are seasonally adjusted, whilst electricity consumption is not. The issues identified for using the data are as follows:

- **Access:** For data to be used in an evaluation, energy suppliers will need to consent. The DECC representative advised that given the request is for government research purposes, this should not be an issue. However in their experience, there have been more concerns raised around commercial data requests, compared with domestic data requests. It was pointed out that data sharing agreements with BIS embedded in the Framework Agreement for evaluation providers may well be sufficient to cover the requirements in this setting. The time lag for requests is expected to be around 5 weeks: the energy suppliers typically respond within 2 weeks.
- **Data-linking:** The process for identifying the user of energy through a particular meter does not yield a 100 percent match owing to the difficulties in matching meters to properties. However, recent experience (as reported by DECC) shows that 80 percent of domestic and 60 percent of non-domestic meters are identified through data-linking to UPRN.
- **Identification:** Issues arise as meters may not necessarily be within a specific property. Industrial estates and business parks may have meters in locations away from the properties themselves and addresses are inconsistently named. It will be necessary to match the addresses for meters with the addresses given for sites of production (which may further erode the potential sample). If unique reference numbers for meters associated with beneficiary and non-beneficiary locations are available, the match rate would be 100 percent. UPRNs of the manufacturing plants are also sufficient.
- **Time lag:** The data are currently published 12 months after the end of year date for that meter type; there are several different reporting dates depending on the type of meter.

Making best use of this data would require energy usage information to be combined with data on GVA to develop an measure of energy consumption per unit of output measure (though estimates of the abatement costs avoided as part of a CBA would need to be driven by total effects on CO₂ emissions).

C3 HMRC Trade Statistics

The HMRC DataLab was launched in May 2011 as a new Research Data Centre (RDC). It allows approved academics to access anonymised HMRC data (in a similar manner to the

ONS Virtual Microdata Laboratory). The HMRC DataLab holds micro-data on trade statistics (imports and exports) that could potentially be linked to records of AMSCI beneficiaries for the purposes of an evaluation. Analyses of possible interest would include the following:

- **Exports:** Firstly, export sales are likely to be subject to lower rates of product market displacement than sales within domestic markets (owing to the likely international profile of competition faced by firms competing in such markets). As understanding the rates of displacement associated with AMSCI is likely to prove a key challenge for an impact evaluation, if the effects of the schemes on exports can be understood in a robust manner, this would provide measures of the economic impacts of the scheme that are at least less likely to represent displacement effects (though it would clearly be possible that at some gain in export share would come at the expense of UK based competitors).
- **Imports of components:** Secondly, if it is possible to identify a treatment and comparison sample of Primes and Tier One suppliers that have benefitted indirectly from AMSCI (these issues are addressed in more detail in the preceding Annex A), it may be feasible to develop estimates of the impacts of AMSCI that are net of any displacement effects. In particular, examining the impact of AMSCI on the import share of the finished goods consumed by Primes and Tier One suppliers would yield estimates of the net increase in domestic demand stimulated by the programme (if there is no increase in the proportion of inputs sourced from domestic suppliers relative to a comparison group, then the inference would be that the scheme's effects would be represent total displacement).

Annex D: Other Government Programmes

Table D1: Wider monitoring availability

Organisation	Schemes	Monitoring Information	Names / address	Reg/ numbers	Timing	Nature of support	Willingness to share for an AMSCI evaluation
UKTI (advisory support for existing and potential exporters)	<p>Export Marketing Research Scheme (finance)</p> <p>International Trade Advisors (advice)</p> <p>Overseas Market Introduction Service (other marketing support)</p> <p>Tradeshaw Access Programme (other marketing support)</p> <p>Reshore UK</p>	UKTI operate a single CRM system across all programmes. This is supplemented by the PIMS monitoring survey that collects information on jobs created as a consequence of support.	Yes	Unknown	Yes	Advice and support only. Directed to other service if funding appropriate	Initial views suggested that UKTI would not foresee any obstacles in sharing company information for the purposes of an evaluation of AMSCI. The nature of the data collected may have impact on data sharing procedures.
BIS	Employer Ownership Pilot (training)	EOP is being monitored using the Individualised Learners Record maintained by the Skills Funding Agency. While this is an employee level dataset, each employee is associated with an employer code which can be matched to the 'Blue Sheep' database to provide a record of the firms benefitting from training through the programme. However, there are some issues with the accuracy of the data – many programmes are led by intermediaries that submit their own Employer ID rather those of the firms benefitting from training subsidies.	Yes	Partial coverage	Yes	Funding direct to employers rather than via HEI	Firm level data would need to be obtained through a data request to the Skills Funding Agency. The EOP team did not foresee any major obstruction in obtaining this information (particularly as any such request will be submitted on an internal basis).
	Growth Accelerators	Growth Accelerators is managed externally by consortium of providers led by Grant Thornton. However, a single CRM system is used by the lead contractor to monitor the programme, including capturing details of all firms benefitting from the various streams of support and training available through the programme.	Yes	Yes	Yes	Advisory support and access to venture capital	While obtaining an extract of monitoring information may not necessarily be straightforward due to the design of the system, no major obstructions were envisaged in terms of sharing this information within BIS for evaluation purposes.

Table D1: Wider monitoring availability

Organisation	Schemes	Monitoring Information	Names / address	Reg/ numbers	Timing	Nature of support	Willingness to share for an AMSCI evaluation
	Enterprise Capital Funds (access to venture capital) Enterprise Finance Guarantee (credit guarantees)	Monitoring of these programme have been undertaken externally by CfEL. Information is available at a firm level, though attempts to use this information for evaluation purposes showed that in some areas the monitoring information was incomplete.	Yes	Unknown	Yes	Yes	Monitoring information will in principle be available for these schemes. However, owing to the nature of the schemes in some cases, linking will be difficult to achieve (particularly where entrepreneurs have sought to sell their business, resulting in changes in name and ownership). Additionally, data-linking to VML data of EFG beneficiaries suggested some issues with the quality of the match available.
	Manufacturing Advisory Service	If grants are provided, advisors act as monitoring officers. Advisors keep no record of accounts and do not conduct any direct reporting. The Advisors job is to ensure money is being spent as agreed and to validate the initial business plan.	Yes	Yes CRN recorded	Ongoing – incepted in 2004	Advise and access to small grants	No issues sharing information for the purposes of evaluation.
	Regional Growth Fund	Systematic monitoring data are collected for both direct subsidies made through the RGF, and grants awarded by intermediaries running regional or national grant or loan programmes. Data collected at a programme level is less complete that that collected for projects benefitting directly from RGF support.	Yes	Yes	Yes	Yes	Internal agreement to share the data for the purposes of evaluation will need to be sought.
	Advanced Propulsion Centre	Monitoring for this scheme requires grant recipients to provide 6 monthly reports regarding their progress, based on the plan. Information in these reports covers wider business results, such as sales and exports. Further to this, Monitoring Officers' conduct quarterly assessments, to check how projects are doing against their targets.	Yes	Unknown	Recently incepted – ongoing for next 10 years	Funding and support to acquire future funding	Details of applicants are saved on record, Innovate UK record company reference number.
DECC	Low Carbon Innovation Fund	Each project has a DECC based project manager who reports on a monthly basis to an innovation investment board, they are also responsible for monitoring. Monitoring under this scheme is described as more of a partnership rather than overseeing results from funding, although monitoring of results against project milestones occurs.	yes	Unknown	Ongoing – Funded from 2010 - 2015	Offers funding, advice and commissions	Access to data should not pose sever issues, although some sensitivity may exist due to the “innovation” aspect of the work. Agreement may need to be reached between BIS and DECC on sharing.

Table D1: Wider monitoring availability							
Organisation	Schemes	Monitoring Information	Names / address	Reg/ numbers	Timing	Nature of support	Willingness to share for an AMSCI evaluation
TSB	Catapults Smart Grants for R&D Collaborative R&D Low Carbon Vehicle Innovation Platform Agritech	Monitoring of all TSB programmes is conducted in the same way. The level of monitoring is high, but proportional to the level of grant provided. The largest grants necessitate quarterly visits by a monitoring officer (MO). Data are collected on grant recipients and regular reports generated by MOs. These are narrative and no specific KPIs are collected.	Yes	Yes CRN recorded	Ongoing	Funding, facilities, support and guidance dependent on programme	Consultations suggest that much of the data collected would be made available through a standard process adhering to BIS' contractual obligations and normal data protection requirements. Data are not collected on LCVI platform beneficiaries unless they go on to receive financial support via grant facilities.
Aerospace Technology Institute (consultation not complete)	Aerospace Technology Institute	The ATI acts as a centre of expertise on Aerospace technology and the Aerospace industry in the UK. Their output is used by BIS and TSB (Innovate UK) to direct their spending and strategy.	NA	NA	Ongoing main activity began in 2010	Industry level advice to government	Restrictions on data sharing (if data exists) is unknown.
European Commission	7th Framework Programme (until 2013) Competitiveness and Innovation Framework Programme (CIP) (until 2013) Horizon 2020 – the RTD framework programmes combined with CIP (from 2014)	The project level data is collected under two main databases: CORDA (Common Research Data Warehouse) and E-CORDA (External Common Research Data Warehouse). CORDA contains almost up-to date information on Framework Programme activities, and E-CORDA is a snapshot of CORDA extracted semi-annually,	Yes	Unknown	Unknown	Unknown	Data provides detailed participant details: administrative and scientific contact point, the official name of the organisation, organisation type (Higher or Secondary education (HES)), private for profit (excluding education (PRC)), Public body (excluding research and education (PUB)), and Research organisations (REC). Sharing monitoring information with individuals or companies under contact by one or more member states may if necessary obtain full or partial access to the FP dataset, to help conduct studies or analysis.

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