Annex C: Private Investment Impacts

This Annex paper sets out an analysis of the impacts of the Biomedical Catalyst in leveraging private investment into the biotechnology and medical technology sector between 2012 and 2018. The primary focus of this paper is on the causal effects of the programme in helping firms receiving grants from Innovate UK secure additional investment to progress onward development.

Key Findings

The results of this analysis suggest that:

- **Total equity investment raised by firms supported by Innovate UK**: Data from Pitchbook suggests that by 2018, around 55 percent of the 150 firms receiving funding through the Biomedical Catalyst secured follow-on private investment. A total of £3.1bn in private investment was raised after they received the grant, during a period of improving fundraising conditions in the life science sector. Around 42 percent of this was in the form of angel investment, venture finance (angel investment) or funds raised from capital markets (via IPOs or 2POs), and the remainder involved from acquisition deals. These funding rounds involved 134 new investors, of which 60 were domiciled overseas (and a high share of these were US based venture capital funds).

- **Impact of the Biomedical Catalyst on fundraising**: Results of a set of econometric analyses showed that the Biomedical Catalyst had a significant impact on the ability of firms to leverage additional venture finance from the private sector in the medium term. It is estimated the 150 firms benefitting from the programme raised between £562m and £710m in private investment as a direct result of the programme.

- **Cost-effectiveness**: The findings point to a leverage ratio of between £4.99 and £6.36 of private investment raised per £1 of Innovate UK grant spending through the programme. However, some firms benefitting from the Biomedical Catalyst also received grants awarded by Innovate UK through other programmes which may have also contributed to these outcomes. Allowing for this additional public spending reduces these leverage ratios to between £3.99 and £4.99 per £1 of public spending.

- **Benchmarking**: However, even accounting for the totality of Innovate UK support for these companies, the programme appears to have proven an effective instrument for leveraging investment into the healthcare sector. Few past studies have explored the impact of R&D grants on equity financing, so it is difficult to benchmark the relative effectiveness of the programme. Other studies – including evaluations of the Sustainable Agriculture and Food and Low Impact Buildings Innovation Platform – have sought to uncover similar effect using information generated through surveys, but were unable to demonstrate a comparable effect.

- **Late and early stage awards**: Late stage awards accounted for two thirds of the overall impact, while one third of the impact was driven by early stage awards. Larger late stage awards appeared to be substantially more efficient as an instrument for leveraging private investment into beneficiary firms. This may mirror the more intensive capital

---

1 The study ‘Do R&D Subsidies Affect SMEs’ Access to External Financing?’ Meuleman and Maeseneire, 2012, found that only grants for R&D awarded by the Belgian Government to start-ups had a positive effect on external equity funding (and did not provide leverage ratios against which these findings could be compared). No other studies examining this effect were found.
requirements of later stage R&D activity in the sector, and suggests public sector investment this stage can be particularly effective in de-risking projects from the point of view of investors.

- **Feasibility studies**: However, there was no evidence that funding for feasibility studies produced a long-term effect on private investment. It is possible that the relatively small size of feasibility study awards does not produce sufficient de-risking of the technology or balance sheets to leverage additional private funding. However, it is notable that applications for feasibility study awards do not receive additional scrutiny from the Major Awards Committee, and the baseline evaluation prepared in 2015 highlighted possible issues regarding the effectiveness of the independent assessment process in the context of the Biomedical Catalyst.

- **Acquisitions**: While there were a relatively small number of acquisition deals recorded across the portfolio, a large share of these (over 80 percent) involved a transfer of ownership to overseas investors. This raises a possible risk that the intellectual property developed through the programme is ultimately exploited overseas, limiting the long term economic benefits of the programme to the UK (though clearly, the income raised represents a short-term gain for equity holders in the UK).

### Key Hypotheses

The Biomedical Catalyst was expected to facilitate the fundraising efforts of those awarded grants through a variety of mechanisms:

- **Technical de-risking**: The technical progress achieved during the delivery of the project will de-risk investment the project from the perspective of an external investor. For example, projects may demonstrate that a small molecule is soluble, that it produces the desired effects in animal models, or that it is safe to use in humans. This reduces the likelihood of failure, making the firm more attractive to investors.

- **Balance sheets**: Provision of grant funding will also help de-risk the balance sheet of the firm as it increases the cash available to the firm without diluting its equity.

- **Due diligence**: Applications for funding are subject to a due diligence process in which their commercial, economic, and scientific merits are assessed by a panel of independent assessors (drawn from academic and industrial backgrounds). In the case of early and late stage awards, additional scrutiny is applied to the highest scoring applications by the Major Awards Committee. These processes have the potential to reduce due diligence costs for potential investors, or at least offer greater confidence that such costs will not be wasted.

- **Reductions in search costs**: Finally, awards made through the programme are publicised on Gateway to Research and through the Innovate UK grants database. Other studies have provided anecdotal evidence that this publicity can act to reduce search costs for investors.

The aim of this paper is to test the validity of these hypotheses and quantify the magnitude of the causal effects of the programme on external investment levels.

### Data

To explore the causal effects of the programme on investment outcomes, records of all successful and declined applicants scoring above 65 in the independent assessment process for Biomedical Catalyst funding (286 firms in total) were linked to
firm level records of investment activity collected by Pitchbook. Pitchbook tracks market data on angel investments, venture capital, private equity and mergers and acquisitions as available from press releases, regulatory filings, websites, and news articles. This data was used to develop a panel dataset describing the level of private funding attracted by applicants to the Biomedical Catalyst in each year between 2010 and 2018.

Owing to the private nature of the transactions involved, some investments may not be a matter of public record and will not be recorded within the data (for example, where businesses are operating in ‘stealth mode’). In some cases, key details such as the size of the investment placed or details of investors involved are not disclosed and are unavailable. Where no investments were recorded for firms in the sample, an assumption was made for the purposes of analysis that the firm did not raise any equity finance over the period.

**Overview**

The data gathered for this analysis suggested that the 150 firms supported by the Biomedical Catalyst raised substantial levels of investment after they were awarded a grant. Eighty-four firms (55 percent) raised additional funds after being awarded a grant, spanning both equity investments and acquisitions:

- **Equity investment**: Overall, firms raised a total of £1.3bn in equity investment over 134 funding rounds after they were awarded a grant (an average of £8.8m per firm). This included a mix of angel investments, early and late stage investments by venture capital fund (VC funds), private equity investments, and initial and secondary public offerings. Around £440m of this was accounted for by two significant funding rounds. These deals involved a total of 118 new investors in the firms concerned, of which 47 were domiciled overseas.

- **Acquisitions**: In addition, 16 firms were acquired after receiving a grant. These deals involved a further £1.8bn of investment (in four cases, the value of the deal was undisclosed), with three deals accounting for £1.5bn of the total. Thirteen of these firms were acquired by overseas investors from North America (5, £433m), elsewhere in Europe (5, £977m), or Japan or China (3, £278m). Ten of these companies continued to maintain a UK presence in 2018.

The figure below shows the cumulative level of investment in firms receiving grants through the programme between 2010 and 2018.

---

2 For firms receiving multiple awards, this was calculated from the date of their first award.
At the same time, fundraising conditions in the life sciences sector improved substantially between 2010 and 2018. The figure below shows overall investment through venture capital, private investments in public equity (PIPE), and IPO/2POs in UK headquartered firms in the healthcare sector. Overall investment rose from £329m in 2010 to £2.0bn in 2018 (peaking at £3.1bn in 2016). While firms supported through the programme accounted for a meaningful proportion of this investment, this share declined from 26 percent in 2010 to 11 percent in 2018. This raises questions as to how far the grants awarded through programme directly contributed to the funding raised, or whether the firms concerned would have raised similar levels of investment as fundraising conditions improved following the recession of 2008.

Figure 1.2: Investment raised, UK headquartered healthcare firms, 2010 to 2018

---

3 The definition used covered the ‘healthcare devices and supplies’ and ‘pharmaceuticals and biotechnology’ industry sectors, and the ‘digital health,’ ‘life sciences’ and ‘oncology’ industry verticals.
To offer some insight into this question, the figure below compares the average level of equity funding raised by firms receiving grant through the programme to applicants that submitted a potentially fundable application (i.e. scored more than 70 in the assessment process) but were declined following the Funder’s Panel. The figure illustrates that those firms that were awarded a grant raised larger sums of funding than the highest scoring declined applicants by 2018 (£16m in comparison to £7m). However, those awarded grants also tended to have secured larger amounts of external funding before the programme began, and may have been better placed to deepen their funding regardless of the grants received through the Biomedical Catalyst. The remainder of this paper provides a set of detailed econometric analysis examining how far the gross investment effects observed can be attributed directly to the programme.

**Figure 1.3: Average external investment raised, successful and high scoring declined applicants to the Biomedical Catalyst, 2010 to 2018**

![Average external investment raised](image)

*Source: Pitchbook and Innovate UK monitoring information*

**Approach**

**Counterfactual Selection**

A credible quantitative assessment of impact requires comparisons between those benefitting from the programme and an appropriate group of firms that did not, to help determine what may have occurred in its absence. As funds were allocated on a non-random basis, the selection of this group needs to address the potential issues of bias caused by selection into treatment. There are two core sources of selectivity:

- **Self-selection:** Applicants ‘self-select’ by submitting an application for Biomedical Catalyst funding and will differ from non-applicants in systematic ways that could influence the outcomes of interest. As an example, non-applicants may not be exposed to the same forms of financial constraints faced by applicants to the programme, reflecting unobserved properties of the applicant or the project, such as the level of risk associated with the technology. Alternatively, non-applicants may not have been engaged in any innovation effort requiring venture finance. In these cases, comparing firms awarded grants to non-applicants would overstate the effect of the programme, as the latter may be less likely to raise risk finance, regardless of the grants awarded.

- **Independent assessment process:** The problems outlined above can be addressed by drawing the sample of comparator firms of the population of declined applicants (as both successful and declined applicants can be assumed share similar
characteristics motivating their applications for funding). The independent assessment process introduces a second source of selectivity. Applications for funding are judged in terms of their scientific merits, technical feasibility, the quality of the team and the strength of the commercial opportunity. If these judgements are made effectively, it can be assumed successful applicants would outperform declined applicants in the absence of Biomedical Catalyst. However, if deadweight formed part of the deliberations of the assessors or the Major Awards Committee, the bias could potentially run the other way.

To mitigate against the problems identified above, a counterfactual sample of firms was drawn from the pool of 350 declined applications that were received over the eight funding rounds associated with the programme (184 applications were successful). Differences between declined and successful applicants were mitigated by excluding any application receiving a score of less than 65 in the independent assessment process (a minimum score of 70 is generally required for Innovate UK to make awards). This limited the population of declined applications to 222.

The primary outcome of interest for this analysis (level of equity funding raised) was observed at the level of the firm rather than at the level of the project. Numerous firms were involved in multiple applications to the programme over the eight rounds, both successful and declined. To address this issue, a firm was considered a successful applicant if any application submitted was awarded funding, and defined as a declined applicant otherwise. This gave a final sample of 151 firms that were awarded funding, and a comparison sample of 134 firms that submitted at least one high scoring but declined application.

Econometric Approach

While the selection of comparison groups as described above helps address some sources of possible bias, there will be residual concerns regarding possible differences between successful and declined applicants that could distort comparisons (particularly since the dataset constructed contained little information on the characteristics of firms beyond their pre-programme fund raising activity). Further steps to minimise possible sources of bias were taken by specifying the following econometric model:

\[ Y_{it} = \alpha + \beta A_{it} + \alpha_i + \alpha_t + \varepsilon_{it} \]

This model describes the relationship between the cumulative level of external equity investment received by firm \( i \) in year \( t \) (\( Y_{it} \)) as a function of the cumulative number Biomedical Catalyst awards received (\( A_{it} \)). As \( A_{it} \) is a cumulative value, the coefficient \( \beta \) measures the long-term effect of the programme on external equity investment levels. The model is also given a fixed effects interpretation, allowing for both any unobserved differences between firms that do not change with time (\( \alpha_i \)) and any unobserved time specific shocks (\( \alpha_t \)) affecting all firms in the same period (e.g. a general improvement in fundraising conditions). This will produce unbiased findings if there are not unobserved – but time varying – differences between successful and declined applicants.

As the primary aim of the analysis is to establish how far the programme enabled firms to deepen their resources to fund further development of the underlying technology, the outcome variable only includes angel investment, venture capital, PIPE deals, and fundraising on capital markets (IPOs and 2POs). Acquisition deals have been excluded as they imply a transfer of ownership, but do not necessarily imply that additional funding has been made available to the firm. Finally, as the outcome variable of interest cannot take a negative value, Ordinarily Least Squares (OLS) estimates have the potential

\footnote{\( A_{it} \) takes the value of zero in all years for the comparison group.}
to produce biased results. To address this issue, models have been estimated both with OLS and Tobit specifications (with left censoring at zero). All models were estimated with robust standard errors.

**Results**

**Overall findings**

The findings of the regression analysis are set out in the table below. These show:

- **Model 1:** This model does not seek to control for unobserved differences between firms or time specific unobserved shocks. The model suggests that each award made through the Biomedical Catalyst enabled firms to increase their external funding by an average of £8.0m. It should be noted that only lead applicants are included in the analysis, and there may be further effects on collaborators that are not captured here.

- **Model 2:** This model accommodates unobserved differences between firms. This reduces the estimated average impact of each award on external investment to £6.1m, suggested (as expected) that basic comparisons between successful and unsuccessful applicants would tend to overstate the impact of the programme.

- **Models 3 and 4:** These models accommodate both unobserved differences between firms and unobserved time-specific shocks affecting all firms. More stringent controls reduce the estimated impact of each award on external funding to £3.4 to £3.9m. The estimated impact of the programme was slightly higher using a Tobit specification which addresses possible issues caused by the censoring of the outcome variable at zero.

### Table 1.1: Estimated effect of awards made through the Biomedical Catalyst on external funding

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of BMC grants received</td>
<td>8.014***</td>
<td>6.076***</td>
<td>3.381**</td>
<td>3.839***</td>
</tr>
<tr>
<td>Model</td>
<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
<td>Tobit (RE)</td>
</tr>
<tr>
<td>Firm level fixed effects</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time fixed effects</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of observations</td>
<td>2,601</td>
<td>2,601</td>
<td>2,601</td>
<td>2,601</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.0473</td>
<td>0.0493</td>
<td>0.0783</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Source: Pitchbook (2018), Innovate UK monitoring data, Ipsos MORI analysis. ***, **, and * indicate that the estimated coefficient was significant at the 99%, 95%, and 90% level of confidence respectively.

**Relative impact of different types of award**

The table below provides the results of two further models (using OLS and Tobit specifications) seeking to examine the relative effectiveness of the different types of awards made through the programme (feasibility studies, early stage awards, and late stage awards). These findings suggest that the level of leverage is related to the size of the grant:

- **Late stage awards:** Late stage awards were found to have the largest impact of the ability of the firm to raise external investment. The estimated long-term average effect of each late stage award on fundraising was estimated at £12.4m to £13.0m.
- **Early stage awards:** Early stage awards were found to increase the firms external funding by an average of £4.1m to £5.4m.

- **Feasibility studies:** There was no evidence that awards for feasibility studies had a long-term effect on the ability of the firm to raise external finance.

### Table 1.2: Estimated effect of different types of awards made through the Biomedical Catalyst on external funding

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 5</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of feasibility awards</td>
<td>0.166</td>
<td>0.184</td>
</tr>
<tr>
<td>Number of early stage awards</td>
<td>4.116*</td>
<td>5.357***</td>
</tr>
<tr>
<td>Number of late stage awards</td>
<td>12.365***</td>
<td>13.045***</td>
</tr>
<tr>
<td>Model</td>
<td>OLS</td>
<td>Tobit (Random Effects)</td>
</tr>
<tr>
<td>Firm level fixed effects</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time fixed effects</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of observations</td>
<td>2,601</td>
<td>2,601</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.1023</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Source:* Pitchbook (2018), Innovate UK monitoring data, Ipsos MORI analysis. ***, **, and * indicate that the estimated coefficient was significant at the 99%, 95%, and 90% level of confidence respectively.

**Implied leverage ratios**

The estimates above can be used to derive leverage ratios (i.e. the level of private investment levered per £1 of grant spending):

- **Overall impact on private investment:** The table below provides details of the number of awards made through the programme by type of award, which have been multiplied by the estimated effect of those awards on external fund raising (taking the average of Model 5 and 6 above) to give estimates of the overall private funds leveraged by the programme. The overall impact of the programme on external fundraising is estimated at £704m (implying around 46 percent of the overall increase in equity funding can be attributed to the programme).

- **Leverage ratios:** Innovate UK monitoring data suggests the eight rounds of the programme involved public spending of £110.7m. This implies that for every £1 of public spending on the programme, it led to £6.36 in additional private equity investment that would not have been raised otherwise. This may underestimate the overall cost to the public sector as firms may secured funding either before or after they received a Biomedical Catalyst grant, which may have also contributed to these investment outcomes. Analysis of the Innovate UK grants database suggests that lead applicants benefitting from the Biomedical Catalyst spent an additional £30.5m of grants awarded through other programmes (including £5m through Smart and a variety of funding from competitions to advance regenerative medicines, cell therapies, and stratified medicines) by 2018. This brings the total public sector costs involved to £141.2m, reducing the implied leverage ratio to £4.99 per £1 of public spend. It should also be noted that many firms receiving funding through the programme had their origins in MRC funded translational research, the costs of which have not been accounted for here.
Relative effectiveness of funding instruments: The results suggested that the late stage awards were the most efficient instrument in leveraging further private equity investment. Every £1 spent on late stage awards led to an additional £10.01 in additional equity investment, in comparison to £4.66 for early stage awards.

Table 1.3: Estimated leverage ratios by 2018 (£ of external funding raised per £1 of grant funding)

<table>
<thead>
<tr>
<th>Type of Award</th>
<th>Number of awards</th>
<th>Average impact on equity raised (£m)</th>
<th>Total additional equity raised (£m)</th>
<th>Grant spending to 2018 (£m)</th>
<th>Leverage ratio (£ per £1 of public spend)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feasibility studies</td>
<td>96</td>
<td>0</td>
<td>0</td>
<td>12.1</td>
<td>0</td>
</tr>
<tr>
<td>Early stage awards</td>
<td>52</td>
<td>4.7</td>
<td>246.3</td>
<td>52.9</td>
<td>4.66</td>
</tr>
<tr>
<td>Late stage awards</td>
<td>36</td>
<td>12.7</td>
<td>457.4</td>
<td>45.7</td>
<td>10.01</td>
</tr>
<tr>
<td>Total Biomedical Catalyst</td>
<td>184</td>
<td>-</td>
<td>703.7</td>
<td>110.7</td>
<td>6.36</td>
</tr>
<tr>
<td>Other Innovate UK awards</td>
<td></td>
<td></td>
<td></td>
<td>30.5</td>
<td></td>
</tr>
<tr>
<td>Total Innovate UK spend</td>
<td></td>
<td></td>
<td>703.7</td>
<td>141.1</td>
<td>4.99</td>
</tr>
</tbody>
</table>

Source: Pitchbook (2018), Innovate UK monitoring data, Ipsos MORI analysis.

Robustness Checks

The results set out above are robust to unobserved differences between successful and declined applicants that do not vary with time. However, there may be time varying differences between the two groups that could bias these findings. For example, if successful applicants were more likely to be pursuing technologies that attracted increasing interest from VC funds over the period, then the results above would overstate the impact of the programme.

As funds were awarded in sequence of 8 funding rounds between 2012 and 2015, it is possible to limit comparisons to successful applicants and exploit staggering in timing of awards to identify the effects of the programme. Under this approach, firms receiving grant awards in later rounds act as a counterfactual for those receiving grants later (on the basis that those awarded funding first should experience their impacts first). As comparisons are only made between successful applicants, this mitigates the possible issue of bias driven by differences to those firms that were declined.

Implementation of the approach involved applying the econometric model described above, but excluding any firms that did not receive funding at some point. This reduces the pool of observations from 2,601 to 1,360. The findings of these models are set out in the table below:

- Applying more stringent controls reduces the size of the estimated impact of the programme by around 10 percent for late stage awards and by 75 to 85 percent for early stage awards (and the estimated impact was only statistically significant for the latter group of awards under the Tobit specification). This suggests that the estimated impacts set out above may be overstated as a result of time varying, but unobserved, differences between successful and unsuccessful applicants.

- Assuming that the core results are overstated by 20 percent, these findings results imply lower overall impacts in terms of leveraging private sector investment (£562m rather than £704m). The implied leverage ratio also falls to £5.11 per £1 of public sector spending through the programme and to £3.99 per £1 of public sector spending accounting for all grant awards received from Innovate UK.
Table 1.4: Estimated effect of different types of awards made through the Biomedical Catalyst on external funding, pipeline design

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 7</th>
<th>Model 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of feasibility awards</td>
<td>-0.997</td>
<td>-0.771</td>
</tr>
<tr>
<td>Number of early stage awards</td>
<td>3.053</td>
<td>4.505***</td>
</tr>
<tr>
<td>Number of late stage awards</td>
<td>11.016***</td>
<td>11.944***</td>
</tr>
</tbody>
</table>

Model

- OLS
- Tobit (Random Effects)

Firm level fixed effects

- Yes
- Yes

Time fixed effects

- Yes
- Yes

Number of observations

- 1,386
- 1,386

Adjusted R-squared

- 0.1155
- N/A

Source: Pitchbook (2018), Innovate UK monitoring data, Ipsos MORI analysis. ***, **, and * indicate that the estimated coefficient was significant at the 99%, 95%, and 90% level of confidence respectively.