Annex B: Business Performance Impacts

This Annex sets out an analysis of the impacts of the Biomedical Catalyst on business performance outcomes for firms applying for funding through the Biomedical Catalyst programme between 2012 and 2017. This paper focuses on the impact of the programme on firms receiving grants from Innovate UK in terms of raising the employment, turnover and productivity.

This analysis uses administrative records on firm performance made available by the Office for National Statistics through the Secure Research Service (SRS). This work was produced using statistical data from ONS. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

Key Findings

The results of this analysis suggest that:

- The Biomedical Catalyst had an enduring effect on the number of workers employed by lead applicants receiving funding. Grants led to a medium term increase in employment of 11 to 15 percent, and to the creation of an additional 234 to 330 jobs. This figure is based on comparisons to a sample of firms that were not awarded funding and is net of deadweight.

- The results did not suggest the programme has led to significant effects on the turnover or productivity of firms. This is expected given the duration of product development cycles in the sector. It is also consistent with the findings from the survey that showed that while applicants have progressed development of the technologies under development more rapidly as a result of the grant, few have launched a product to market.

- The apparent effects of the programme on employment are interpreted as a sign of greater levels of investment in R&D activity rather than the recruitment of production, commercial management, or sales and marketing staff. As firms have not seen revenue growth as a result of the programme, it is unlikely that there have been any offsetting job losses amongst competing firms as a result of displacement of sales. There is a possibility that additional demand for skilled labour placed pressure on wages, encouraging other firms to scale back their activities. However, broader trends in the pharmaceutical sector suggest that this may not have been likely.

- The average employment of those awarded grants began to diverge from the group of firms declined funding from 2015 onwards. This coincides with the period in which firms awarded grants began to attract greater levels of equity funding (as shown in Annex C). It is possible to draw the inference that it was the effect of the programme in leveraging this additional funding that led to the observed effects on employment.

- Assuming the additional jobs created are primarily in R&D occupations, it is estimated that the programme led to an increase in R&D spending of £234m to £330m by 2018. Allowing for public contributions of £141m, it is estimated that between £107m and £208m of this represents private spending on R&D. This implies the programme levered an additional £0.76 to £1.48 of private R&D spending per £1 of public sector spending. These findings suggest that the

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1 These figures are based upon the firms which were successfully linked to ONS held records at the SRS. Care was taken to clean the company reference numbers throughout Biomedical Catalyst applications, however it was not possible to successfully link every firm. Further details on the linking and the data available for analysis can be found in the data section of this paper.
Biomedical Catalyst has been at least as effective (and potentially up to twice as effective) as R&D Tax Credits in leveraging additional private R&D spending.

- Findings from other analyses suggest the programme enabled firms to raise an additional £533.5m to £609.8m in external investment. Given the apparent rate at which this investment has been ‘burnt,’ firms receiving grants are likely to have developed significant reserves with which to continue their R&D efforts. As such, effects on R&D employment and spending are likely to be sustained well beyond 2018.

- Grants appeared to have no impact on industrial collaborators or subcontractors. While the number of collaborators included in the analysis was small, these findings suggest that any multiplier effects resulting from additional R&D spending were trivial.

### 1.1 Key Hypotheses

The Biomedical Catalyst has the potential to result in greater levels of economic activity through the following mechanisms.

#### 1.1.1 Greater levels of R&D activity:

In the short to medium term, grants awarded through the programme could be expected to lead to increased levels of R&D spending, assuming they are not used to either fund activities that the private sector would have funded anyway (deadweight) or encourage the diversion of resources from parallel programmes of development activity (crowding out).

Greater spending on R&D may induce some firms to increase their employment of R&D workers. However, greater R&D expenditure will not necessarily feed through to the recruitment of new workers to the extent that the additional spending is placed with contractors (such as Contract Manufacturing Organisations producing materials required for tests). The sector has also seen the emergence of ‘virtual’ business models in which R&D programmes are almost exclusively delivered through a system of subcontracts with suppliers. In this case, the impact of additional spending on employment might be anticipated within the supply chain rather than at the level of firms applying for grant funding (known as multiplier effects).

Additionally, greater demand for the required inputs to the R&D process - such as skilled labour - could place pressure on wages and other prices. This could have offsetting effects elsewhere in the economy by reducing demand for labour and other inputs amongst other firms. In a closed economy operating at full employment, any expansion in employment amongst firms receiving grants will be neutralised by these types of effect. However, employment may still rise in net terms if firms are able overcome labour supply constraints by attracting workers from overseas.

#### 1.1.2 Exploitation

In the long term, firms successfully developing their technologies may move into an exploitation phase in which they seek to commercialise the underlying products or services that have been refined through the R&D process. To do so, firms will need to scale-up their operations to market their products or services, navigate complex procurement systems in public and private healthcare systems, or invest in production operations and staff. Assuming firms can find a market for their products, this would be expected to lead increases in sales or turnover, as well as increases in employment and output (GVA). The productivity of the firm will also potentially rise as it moves from investment in R&D to productive activities.

Again, there are several complexities that must be considered:
• **Product development timescales:** Product development timescales are long term in nature. While this evaluation covers a group of firms that received grants between 2012 and 2015, the timescales involved with bringing new technologies to market are extensive. This is particularly true of new therapeutics and, as such, it may be too early in the development process to expect significant commercialisation effects.

• **Resource requirements:** Additionally, completing the product development process may require a level of resources that cannot be brought to the project by an SME. For example, Phase III clinical trials involve extensive testing programmes (potentially in multiple regulatory jurisdictions) as the focus shifts to demonstrating the effectiveness of the product relative to competing treatments and exploring possible side-effects in different groups of patients. As such, the firms leading the initial development of the product may seek to license the technology to (or enter some other form of collaboration agreement with) a large pharmaceutical firm with deeper resources to take forward development. Alternatively, the firm may seek to achieve an exit to such a company. In these cases, the long term economic outcomes may be difficult to trace as production of the underlying technology will be taken forward by another firm.

• **Displacement and crowding out:** Where firms do successfully commercialise a new product, there are also offsetting effects that need to be accounted for. Firstly, if firms claim market share from domestic competitors that produce alternatives, there may be corresponding loss of revenues, output and employment elsewhere in the UK. Even where sales are taken from overseas competitors, additional demand for labour and other inputs may also put pressure on wages and other prices, encouraging other firms to reduce their production. These effects need to be understood to develop an understanding of the net economic impacts involved.

### 1.2 Data

This analysis is based on longitudinal observations of employment and turnover at the level of individual firms which have been taken from the Business Structure Database (BSD). The BSD is an annual snapshot of the Interdepartmental Business Register and provides longitudinal observations of employment and turnover for all firms in the register between 1998 and 2017, and is used as the main sampling frame for ONS business surveys.

The underlying data on employment and turnover is taken from PAYE and VAT returns (or from Annual Business Survey or Business Register of Employment Survey returns if the firm is included in the sample of these ONS Surveys). These arrive with different lags and are recorded as and when data arrives. These types of issue are more acute for evaluations considering short time horizons, and given the time span under consideration in this evaluation (2012 to 2017), the extent of these types of bias will be less acute. However, it should be acknowledged that the analysis below is likely to understate the effects on the programme on turnover and revenues.

To explore the causal effects of the programme, records of firms included in Biomedical Catalyst applications that submitted full applications were linked to the BSD. This was achieved by linking the Companies House Reference numbers of firms associated with successful and unsuccessful applications to the programme. This sample covered lead applicants, collaborators, and subcontractors (a sample of 826 unique firms in total). CRNs for lead applicants and collaborators were taken from the application form, while CRNs for UK based subcontractors were determined (where feasible) from Companies House searches.

A total of 614 firms were successfully matched with complete records within the SRS (277 of 314 lead applicants leads, 32 of 32 collaborators and 248 of 470 subcontractors). This equates to 74 percent of the 826 companies of the overall sample, with matching rates highest for collaborators (100 percent) and lowest for subcontractors (52 percent).
For the purposes of future evaluation, it is understood that BEIS has now constructed a longitudinal IDBR for analysis and evaluation which addresses some of the known problems with the Business Structure Database. This database uses more recent PAYE and VAT data provided by HMRC, providing more up-to-date measures to facilitate more accurate evaluation. It is also advised that Innovate UK ensures that this source is considered in the preparation of future evaluation studies of other programmes involving support for industrial R&D, given its potential to enhance the timeliness of findings.

1.3 Changes in business performance

The data gathered for this analysis suggested that the firms receiving funds from the Biomedical Catalyst saw their average employment remain static between 2012 and 2017 (at 123 to 125 employees). However, the average turnover of firms fell substantially over the same period (from £51m in 2012 to £23m in 2017). These patterns were dominated by those firms acting as subcontractors to lead applicants – this group included large Contract Research Organisations (CROs) and Contract Manufacturing Organisations (CMOs) which were substantially larger than the small companies that tended to take the lead role (e.g. the average employment of lead applicants was 22 employees in 2017, compared to almost 200 for subcontractors). These patterns may reflect stagnation in pharmaceutical R&D spending since 2012, which has remained comparatively static after a long period of expansion.

Looking specifically at lead applicants:

- Those firms awarded grants tended to be larger than those that applied but were declined funding when the programme was launched in 2012. Firms awarded grants employed an average of 14.6 workers in 2012 (relative to 11.7 amongst those declined), and were generating average annual turnover of £1.3m (relative to £0.9m amongst unsuccessful applicants. Assuming turnover per worker can be treated as a measure of underlying efficiency, there were some suggestions that lead applicants awarded grants were also slightly more productive. However, there was a large amount of variation across the sample, and these apparent differences were not statistically significant.

- The average employment of firms awarded grants grew by 48 percent to 21.5 workers by 2017, while remaining virtually unchanged amongst those that applied but were not awarded the grant (11.5 workers). These differences were significant at the 95 percent confidence level, with much of the employment growth amongst firms awarded grants taking place after 2014.

- Successful applicants to the programme saw their turnover rise by 22 percent over the same period (in nominal terms). Although unsuccessful applicants saw their turnover rise by 33 percent, there were no statistically significant differences in the average turnover or turnover per worker between the two groups in 2017.

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Note that this average will be affected by some large firms dropping out of the sample, for example, where large CROs were subject to an acquisition. Average turnover per worker remained relatively stable across the period.
Econometric analysis

The findings above suggest firms awarded grants expanded their employment relative to those that applied for grants but were declined (though not their turnover or turnover per worker). However, this should not be taken as a measure of the causal effect of the programme, as these results may be product of underlying differences between successful and unsuccessful applicants for funding. This section provides the results of a series of econometric analyses seeking to provide estimates of the impact of the grants on these metrics of firm performance.

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 influence to 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 which could limit future revenue or staffing levels. In these cases, comparing firms awarded grants to non-applicants would overstate the effect of the programme, as the latter may see limited growth in employment and turnover.

- **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). The primary outcomes of interest for this analysis (employment, turnover, turnover per worker) were observed at the level of the enterprise rather than at the level of the project and 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.

Econometric Approach

This approach helped address the first problem outlined above, but leaves potential concerns that differences between successful and unsuccessful applicants may be driven by differences in their underlying characteristics rather than the grants themselves. The following section describes the analytical strategy employed to mitigate these concerns.

To estimate the causal effects of the Biomedical Catalyst on the business outcomes of interest, the following econometric model was adopted:

\[
Y_{it} = \alpha_i + \beta T_{it} + \gamma t + \delta X_{it} + \alpha^t + \alpha^* + \epsilon_{it}
\]

In this model, the performance firm \(i\) in period \(t\) (\(Y_{it}\), representing employment, turnover or turnover per worker) is determined by its exposure to Biomedical Catalyst funding (\(\beta T_{it}\)), and the parameter \(\beta\) gives an estimate of the effect of interest (representing the long-term effect of the grant on the outcome of interest). The model also allows for general trends affecting all firms in the sample (\(\gamma t\)) as well as firm characteristics including their industrial sector and the region in which they were located (\(X_{it}\)). As noted above, estimates of the impact of the programme have the potential to be biased by differences between successful and unsuccessful applicants. The following approaches were taken to address this problem, exploiting the longitudinal nature of the data:

- **Fixed effects**: The model was augmented to allow for unobserved differences between firms that do not change with time (\(\alpha^t\)). This captures the effect of any unchanging qualities of the firm that may have influenced both its success in the application process and its performance – this could represent the effectiveness of its commercial management team or the strength of its underlying intellectual property or its business model (although results could still potentially be biased to the degree that these factors change over time).

- **Time-specific shocks**: The model also allows for any unobserved but time specific shocks affecting all firms in the sample (\(\alpha^*\)). Examples of this might be the apparently favourable conditions for IPOs in 2015, or the effects of the EU Referendum in 2016.

- **Pipeline design**: The robustness of results was also tested by restricting comparisons only to firms that were successful in the application process at some stage. In principle, this eliminates any biases driven by differences between successful and unsuccessful applicants. However, biases could arise if there are systematic differences in the characteristics of firms

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3 This variable takes the value of 0 in the years before firms receive a grant, and 1 in the following years. For firms forming the comparison group, this variable takes the value of 0 in all years.
awarded funding in different competition rounds (e.g. if applicants in later rounds produced higher quality proposals then they might be expected to grow more rapidly than those supported in earlier rounds, leading to an underestimation of the effects of the programme).

Results

The findings of the econometric analyses using the full sample of firms (i.e. leads, collaborators, and subcontractors associated with successful and unsuccessful applications for funding) are set out in the table below:

- **Model 1**: This benchmark model applies a simple OLS model exploring the relationship between receipt of grant and the outcomes of interest (expressed in terms of their absolute values). These results imply that BMC funding led to a decrease in turnover per worker of around £17,000, but do not allow for unobserved differences between firms or unobserved time specific shocks.

- **Model 2**: These regressions repeat those above but with the outcomes variables transformed into log values. In this case, the coefficient provides an estimate of the percentage effect of grants awarded on the outcome of interest. Here, the results suggest the grants had a significant impact on both employment and turnover (37 percent increase in employment and a 26 percent increase on turnover). Again, these models do not allow for unobserved differences between firms or unobserved time specific shocks.

- **Model 3**: This model implements the specification in 1.4.3 which includes fixed effects at the firm level. These estimates should be more robust that those identified above. However, no significant effects are evident when comparing all firms receiving funding with those that applied for funding but did not receive a grant.

- **Model 4**: These regressions repeat those of model 4 above but are expanded to also include year fixed effects that account for any unobserved time specific shocks. These also do not suggest that the grants had a significant effect on the outcomes of interest across the full sample of firms included in the analysis.

It is concluded from these models that the Biomedical Catalyst had no effect on the outcomes of interest across the whole sample of firms included in the analysis.

**Table 1.1: Estimated effect of awards made through the Biomedical Catalyst on business performance (all firms - lead applicants, collaborators, and subcontractors)**

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firms included</td>
<td>All</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>Model</td>
<td>OLS</td>
<td>OLS</td>
<td>Fixed Effects</td>
<td>Fixed Effects</td>
</tr>
<tr>
<td>Dependent variable</td>
<td>Absolute</td>
<td>Log transformed</td>
<td>Log transformed</td>
<td>Log transformed</td>
</tr>
<tr>
<td>Year Fixed Effects</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Outcome</td>
<td>Coeff.</td>
<td>R²</td>
<td>Coeff.</td>
<td>R²</td>
</tr>
<tr>
<td>Employment</td>
<td>29.42</td>
<td>0.055</td>
<td>0.371***</td>
<td>0.115</td>
</tr>
<tr>
<td>Turnover (£,000)</td>
<td>21,270*</td>
<td>0.032</td>
<td>0.261***</td>
<td>0.125</td>
</tr>
<tr>
<td>Turnover per worker (£,000)</td>
<td>-16.86**</td>
<td>0.053</td>
<td>-0.0741</td>
<td>0.088</td>
</tr>
</tbody>
</table>
A further series of models were run to explore differential effects across different types of firm (i.e. leads and collaborators). The results of these analyses are presented below:

- **Model 5:** This model repeats Model 4 but allows for differential effects across lead applicants and collaborating partners. These models suggest that the grants awarded through the programme led to an increase in the employment of lead applicants of around 15.1 percent, though no such effect is present for collaborators (though this latter result may be a function of the small number of collaborators in the sample). No effects on turnover or turnover per worker were identified.

- **Model 6:** Finally, Model 6 restricts comparisons to successful applicants (implementing the pipeline design described above). These models find qualitatively similar results, though the estimated effect on the employment of lead applicants falls to 10.7 percent. There is a suggestion that the programme may have had a negative effect on the turnover of collaborators (of around 7.7 percent), though caution is urged with this result owing to the small number of firms feeding into this finding. These finding are potentially more robust than those associated with Model 5, as they will not be distorted by unobserved but time varying differences between successful and unsuccessful applicants. However, as noted, there may be unobserved differences between applicants in different rounds that could bias findings.

### Table 1.2: Estimated effect of awards made through the Biomedical Catalyst on business performance by role

<table>
<thead>
<tr>
<th></th>
<th>Model 5</th>
<th>Model 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firms included</td>
<td>All</td>
<td>Successful applicants</td>
</tr>
<tr>
<td>Model</td>
<td>Fixed Effects</td>
<td>Fixed Effects</td>
</tr>
<tr>
<td>Dependent variable</td>
<td>Log transformed</td>
<td>Log transformed</td>
</tr>
<tr>
<td>Year Fixed Effects</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Outcome</strong></td>
<td><strong>Coeff.</strong></td>
<td><strong>Coeff.</strong></td>
</tr>
<tr>
<td><strong>R²</strong></td>
<td><strong>R²</strong></td>
<td><strong>R²</strong></td>
</tr>
<tr>
<td><strong>Lead</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment</td>
<td>0.151***</td>
<td>0.167</td>
</tr>
<tr>
<td>Turnover (£,000)</td>
<td>0.0400</td>
<td>0.057</td>
</tr>
<tr>
<td>Turnover per worker (£,000)</td>
<td>-0.219</td>
<td>0.039</td>
</tr>
<tr>
<td><strong>Collaborator</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment</td>
<td>-0.0769</td>
<td>0.167</td>
</tr>
<tr>
<td>Turnover (£,000)</td>
<td>-0.069*</td>
<td>0.057</td>
</tr>
<tr>
<td>Turnover per worker (£,000)</td>
<td>-0.455</td>
<td>0.039</td>
</tr>
<tr>
<td><strong>Subcontractors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment</td>
<td>-0.277</td>
<td>0.167</td>
</tr>
<tr>
<td>Turnover (£,000)</td>
<td>-0.307</td>
<td>0.057</td>
</tr>
<tr>
<td>Turnover per worker (£,000)</td>
<td>0.014</td>
<td>0.039</td>
</tr>
</tbody>
</table>

Source: Business Structure Database (2018), Biomedical Catalyst Application Information, Ipsos MORI analysis. ***, **, and * indicate that the estimated coefficient was significant at the 99%, 95%, and 90% level of confidence respectively.

To add following ONS clearance.
Discussion

Effects on R&D employment and spending

The results above show that the Biomedical Catalyst had an impact on the employment of lead applicants, but was yet to have an impact on turnover or productivity. This result can be explained by the long product development timescales involved in the sector. As shown in parallel analysis, while successful applicants for funding have progressed the development of their underlying technologies more rapidly due to the grant, few have progressed so far that they have launched a new product to market. As such, the assumption has been made that the jobs created have primarily been in R&D occupations.

To reach an estimate of the gross additional R&D jobs created and R&D spending leveraged as result of the programme, the following assumptions have been adopted:

- **Average number of jobs created**: Estimates of the effect of grant funding on the employment of lead applicants (i.e. 10.7 to 15.1 percent) were applied to their average employment in the year the programme was launched (i.e. 14.6 jobs). This gives a low to high range for the average number of jobs created as a result of the programme of 1.6 to 2.2 jobs per firm benefitting from the programme.

- **Total R&D jobs created**: Applying this to the number of (unique) firms awarded grants through the programme (150), gives an estimate of the total number of R&D jobs created of between 234 and 330 jobs. This is equivalent to between 0.9 and 1.4 percent of total R&D employment in the pharmaceutical sector (24,000 in 2016).

- **R&D employment years**: To estimate the number of R&D employment years created by the programme between 2012 and 2018, estimates of the average effect of the programme on employment were applied to the cumulative number of firms receiving grants. As the econometric analysis provides estimates of the average ‘permanent’ effect of the grant on employment, these effects have been applied from the year in which the grant was awarded onwards. An assumption is also made that these effects endure into 2018 for comparability with findings derived in other analyses.

- **R&D spending**: An estimate of the total R&D spending levered by the programme was derived by applying average R&D spending per R&D worker reported by successful applicants to the Biomedical Catalyst (£182,209) to the total number of R&D employment years. This value was broadly consistent with pharmaceutical sector averages in 2016 (£171,750). This gave an estimated of the total additional R&D spending levered by the programme of between £248m and £349m (i.e. R&D spending attributable to the grant).

These results are set out in the following table.

### Table 1.3: Estimated impact of the Biomedical Catalyst on R&D employment and spending

<table>
<thead>
<tr>
<th>Year</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. firms receiving grants (cumulative)</td>
<td>38</td>
<td>98</td>
<td>136</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>R&amp;D jobs created (high)</td>
<td>84</td>
<td>216</td>
<td>300</td>
<td>330</td>
<td>330</td>
<td>330</td>
<td>330</td>
<td>1,920</td>
</tr>
<tr>
<td>R&amp;D jobs created (low)</td>
<td>59</td>
<td>153</td>
<td>212</td>
<td>234</td>
<td>234</td>
<td>234</td>
<td>234</td>
<td>1,361</td>
</tr>
</tbody>
</table>

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5. I.e. 14.6 multiplied by 0.107 or 0.151.
6. I.e. 150 multiplied by 1.6 or 2.2.
The results above give estimates of the employment impacts of the programme that are net of deadweight but do not consider possible offsetting effects elsewhere in the economy. As the programme has not yet had an effect on the turnover of those firms receiving funding, it is unlikely that there have been any displacement effects resulting from the loss of market share of competitors based elsewhere in the UK economy.

However, the results above imply that the programme stimulated additional for inputs into the R&D process (such as skilled workers). This could have placed pressure on prices, leading to reductions in demand elsewhere in the economy. An analysis of the Business Expenditure on Research and Development survey completed by ONS suggests that this may be unlikely. Average salaries of R&D workers in the pharmaceutical sector fell between 2010 and 2016 (from around £80,000 to £75,000 in 2017 prices), as overall R&D spending contracted in the sector over the period.

Cost Effectiveness

This final section considers the effectiveness of the Biomedical Catalyst in leveraging additional private R&D spending. The table below compares estimates of the total increase in R&D spending attributable to the programme (Innovate UK grants only) to the R&D spending funded publicly – either directly through the programme, or through other awards received between 2012 and 2018:

<table>
<thead>
<tr>
<th>R&amp;D spending (high, £m)</th>
<th>15.2</th>
<th>39.3</th>
<th>54.6</th>
<th>60.2</th>
<th>60.2</th>
<th>60.2</th>
<th>60.2</th>
<th>349.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D spending (low, £m)</td>
<td>10.8</td>
<td>27.9</td>
<td>38.7</td>
<td>42.7</td>
<td>42.7</td>
<td>42.7</td>
<td>42.7</td>
<td>248.0</td>
</tr>
</tbody>
</table>

Source: Business Structure Database (2018), Biomedical Catalyst Application Information, Ipsos MORI analysis.

▪ **Public spending:** Analysis of the Innovate UK grants database suggests that a total of £110.7m of public funding was absorbed in the delivery of the programme by October 2018. In addition, lead applicants spent a further £30.5m in grants awarded through other Innovate UK programmes between 2012 and 2018, bringing the total estimated public contribution to the R&D spending of lead applicants to £141.2m.

▪ **Private spending levered:** Subtracting the estimated public contribution gives an estimated of the private R&D spending levered of between £106.8m and £208.7m.

▪ **Leverage ratio:** This equates to a ratio of private R&D spending of between £0.76 and £1.48 per £1 of public spending. This suggest that the programme has complemented, rather than crowded out, private R&D expenditure. The findings of a 2016 evaluation of R&D Tax Credits in the UK suggested that R&D tax credits raised private R&D spending by £0.70 per £1 of public subsidy. These estimates suggest that the Biomedical Catalyst has been at least as effective (and potentially up to twice as effective) as tax based instruments in leveraging additional R&D spending.

▪ **Persistence:** Findings elsewhere that the Biomedical Catalyst enabled lead applicants to raise between £533.5m and £609.8m in additional external funding (i.e. over and above what they may have could raise in the absence of the programme). This suggests that those firms benefitting from the programme will be able to draw on significant capital reserves to fund their future R&D activity. As such, these effects are expected to persist into the future, raising confidence that the firms concerned will be able to achieve future commercialisation milestones (notwithstanding issues of technical and commercial risk, which are high in the sector).

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Table 1.4: Estimated leverage ratios (£ of additional private R&D spending per £1 of public spending)

<table>
<thead>
<tr>
<th>R&amp;D spending</th>
<th>Increase in R&amp;D spending attributable to BMC by 2018 (£m)</th>
<th>Expenditure of Biomedical Catalyst grant by 2018 (£m)</th>
<th>Expenditure of other Innovate UK grants by 2018 (leads) (£m)</th>
<th>Total public contribution by 2018 (£m)</th>
<th>Implied private R&amp;D spending leveraged (£m)</th>
<th>£ of private R&amp;D levered per £1 of public spend</th>
</tr>
</thead>
<tbody>
<tr>
<td>(high)</td>
<td>349.9</td>
<td>110.7</td>
<td>30.5</td>
<td>141.2</td>
<td>208.7</td>
<td>1.48</td>
</tr>
<tr>
<td>(low)</td>
<td>248.0</td>
<td>110.7</td>
<td>30.5</td>
<td>141.2</td>
<td>106.8</td>
<td>0.76</td>
</tr>
</tbody>
</table>

Source: Business Structure Database (2018), Biomedical Catalyst Application Information, Ipsos MORI analysis.