

# Lessons for industrial policy from development of the Oxford/AstraZeneca Covid-19 vaccine

Industrial Strategy Council



Research Paper

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# About the Industrial Strategy Council

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The Industrial Strategy Council ('the Council') is an independent non-statutory advisory group established in November 2018. It is tasked with providing impartial and expert evaluation of the government's progress in delivering the aims of the Industrial Strategy. Its membership is comprised of leading men and women from business, academia and civil society.

## Acknowledgements

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# Executive summary

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In January 2020, academics and members of the life sciences industry in the UK began to explore developing a vaccine against Covid-19. As part of the Government's mission to secure Covid-19 vaccines for the UK population, it put in place support to ensure any prototype vaccine created in the UK could be developed and manufactured domestically. The mission also sought to expedite the process as much as possible while maintaining the usual safety standards.

On 4 January 2021, the first doses of the UK-developed Oxford/AstraZeneca Covid-19 vaccine (Ox/AZ vaccine) were administered to patients. The process for developing a new vaccine can take up to 15 years. UK scientists, industry, government and the public had cooperated to compress this timeline to under a year.

This paper draws lessons from the UK's Covid-19 vaccine procurement programme for future industrial policy. Our focus is on how the Government's mission to secure safe vaccines at speed helped compress the development process for the Ox/AZ vaccine. We also explore the factors already in place prior to the pandemic that were a necessary condition for developing a vaccine so quickly.

The Ox/AZ vaccine serves as a useful case study to help surface lessons from the wider programme under the auspices of the Vaccines Taskforce (VTF). Although it was one of many vaccines procured by the Government, development of the Ox/AZ vaccine took place mostly in the UK and so provides a window into how the Government influenced each stage of the process. Consequently, the paper does not provide a definitive account of the vaccine procurement programme. Deployment of Covid-19 vaccines is also out of scope, as it is ongoing at the time of publication.

We find that government played a key role in expediting every stage of the Ox/AZ vaccine development process. Based on our analysis we identify six lessons for future industrial policy and how missions might be deployed:

- 1. Choose a small number of clear, measurable missions and make them a priority at the highest levels of government.** The clarity and urgency of the vaccine mission was central to shortening the timeline for developing the Ox/AZ vaccine. A clear mission with very senior sponsorship can support ministers and senior officials to innovate, through setting up structures dedicated to achieving the objective and simplifying processes. While not all areas of industrial policy warrant this approach, missions should be set for a few high priority areas.
- 2. Map out an end-to-end path to success.** Government played a role in every stage of the Ox/AZ vaccine's supply chain. The absence of government involvement at any stage of the process would have delayed development of the vaccine. This shows the importance of a thorough understanding of end-

to-end supply chains as an essential ingredient for successful missions. It is also a lesson applicable to UK industrial policy more generally.

- 3. Harness the public, private and voluntary sectors in co-creating and co-delivering industrial policy.** Development of the Ox/AZ vaccine inside a year was made possible by the combined efforts of scientists, venture capitalists, manufacturing experts, regulators, civil servants and volunteers. Co-creation and co-delivery, principally through the VTF, was critical. The success of this multi-skilled approach demonstrates the value in industrial policy harnessing the respective comparative advantages of the public, private, and voluntary sectors.
- 4. Use strategic procurement and financial insurance to drive progress against industrial policy objectives.** The Government's willingness to commit public money towards de-risking the Ox/AZ vaccine development process for the University of Oxford and AstraZeneca was critical to success. There is value in taking financial risks where a case can be made that they will materially enhance the chances of solving policy challenges. This approach lends itself to mission-oriented policy. It is likely to work best for issues of significant societal or economic importance, where the market alone will not deliver solutions fast enough or even at all.
- 5. Provide long-term investment at scale as part of sector strategies to maximize the UK's industrial, commercial and technological strengths.** The foundations for developing the Ox/AZ vaccine lay in the UK's comparative advantage in life sciences and especially vaccines research. These strengths were, in part, the result of investment by successive governments, including as a component of the 2017 Industrial Strategy. It demonstrates how persistent strategic investment at scale in core strengths generates value for the economy.
- 6. Build resilience as part of industrial policy.** Gaps in manufacturing capacity threatened the UK's ability to produce the Ox/AZ vaccine domestically. This illustrates the importance of 'defensively' maintaining key parts of the UK's infrastructure, in particular a manufacturing base, as resilience against future crises. Risk minimisation should exist alongside maximising returns as a criterion for choosing where supply-side support for the economy is directed.

# Introduction

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The UK Government's Covid-19 vaccine procurement programme is heralded as a flagship success of its response to the pandemic, securing a timely supply of vaccines for the UK population. It is also a natural experiment in the type of 'mission-orientated' industrial policy the Government has trailed in recent years. The public sector had a hand in every aspect of expediting the development of new vaccines, from the pre-pandemic discovery phase and clinical trials to emergency procedures in support of regulatory approval and building capacity for large-scale manufacturing.

This paper draws lessons from the UK's Covid-19 vaccine procurement for future industrial policy. Our focus is on how the Government's mission to secure safe vaccines at speed helped compress the development process for the Ox/AZ vaccine. We also explore the factors already in place prior to the pandemic that were a necessary condition for developing a vaccine so quickly.

The Ox/AZ vaccine serves as a useful case study to help surface lessons from the wider procurement programme under the auspices of the VTF. Although it was one of many vaccines procured by the Government, development took place mostly in the UK and so provides a window into how the Government's mission impacted each stage of the process. The paper is not a definitive account of the vaccine procurement programme, while the deployment of vaccines (which is ongoing at the time of publication) is out of scope. We concentrate on how government supported turning Covid-19 vaccines from a vision into safe, viable and mass-produced products. The evidence is drawn from a review of information contained in publicly available documents and articles, and interviews with civil servants who worked on the VTF during 2020.

# Missions and crises

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Over the past decade academic work on mission-oriented industrial policy has influenced industrial strategy for several jurisdictions globally, including the UK.<sup>1</sup> Research into how government has driven innovation and supported some of the world's most successful industries has led to a shift in thinking on the role of the state in shaping economies.<sup>2</sup>

The UK Government followed a mission-oriented approach in developing its 2017 Industrial Strategy White Paper.<sup>3</sup> Under the banner of 'Grand Challenges', it identified four social issues to be prioritised: AI & Data-Driven Economy, Clean Growth, Future of Mobility and Ageing Society.<sup>4</sup> Each Grand Challenge was assigned missions to drive implementation. The language of mission-based policy, such as references to 'moonshots' or 'wicked problems', has also become commonplace to describe tackling complex public policy problems.

## Mission-oriented industrial policy

The mission-oriented industrial policy literature emerged from a realisation that the most pressing social issues governments face are complex, systemic, interconnected, and urgent.<sup>5</sup> Therefore, they require insights from many perspectives, innovation-driven solutions, and novel ways of delivering policy. The blueprint for this new approach to policy was provided by organisations such as the Defense Advanced Research Projects Agency (DARPA), founded in 1958 in the US, and widely acknowledged to have provided early investment into some of the key innovations that later became building blocks for the success of Silicon Valley.<sup>6</sup>

The literature also draws a distinction between wide and narrow missions. The former covers a wide range of far-reaching actions aimed at creating societal and economic change, such as the Grand Challenges, while the latter refers to pursuing

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<sup>1</sup> Mazzucato M. (2018), *Mission-Oriented Research & Innovation in the European Union*, European Commission; The Federal Government of Germany (2018), *The High-Tech Strategy 2025*, Available at: <https://www.hightech-strategie.de/en/index.html>

<sup>2</sup> Mazzucato, M. (2015), *The Entrepreneurial State: Debunking Public Vs. Private Sector Myths.*; Mazzucato M. (2018), *Mission-Oriented Research & Innovation in the European Union*, European Commission

<sup>3</sup> BEIS (2017) *Industrial Strategy: building a Britain fit for the future*, Available at: <https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future>.

<sup>4</sup> HM Government (2017). *Industrial Strategy White Paper: Building a Britain Fit for the Future*.

<sup>5</sup> Mazzucato M. (2015), *Innovation Systems: From Fixing Market Failures to Creating Markets*; Intereconomics

<sup>6</sup> Cameron N. (2018), *The government agency that made Silicon Valley*, in: *Unheard*; Available at: <https://unherd.com/2018/06/government-agency-made-silicon-valley/>

a critical, easily definable breakthrough, like a moonshot. While these types of mission differ in scope, the lessons from one translate to another.

Crucially for our discussion, mission-oriented policies can be characterised by:<sup>7 8 9 10</sup>

- **Directionality** - the state explicitly sets the direction of innovation policy in line with a country's core strengths.
- **Portfolio approach to innovation** - as experimentation is considered one of the key features of innovation, a missions-oriented approach tries to manage risks, rather than avoid them at all cost.
- **Policy coordination** – the need to move away from a ‘siloed’ approach to policy and to ensure sufficient degree of cooperation between different parts of government.
- **Decentralised governance, multiple bottom-up solutions** - involvement of a wide group of key actors to avoid the pitfalls of top-down planning.
- **Cross-discipline, building a system of innovation** - the need to foster collaboration between different elements of the national innovation system to build an innovation ecosystem.
- **Focus on structural change, dynamic efficiency and spillovers** - targeting technological solutions which could bring about change and economic benefits to a wide variety of sectors and create new markets and products. This also requires governments’ project appraisal methodology to capture the full range of benefits from structural changes and spillovers, as opposed to more traditional ‘static’ cost-benefit analysis.
- **Long term horizon and patient finance** - mission-oriented policies often target long-term challenges and, therefore, require long-term financing arrangements.
- **Targeting well-defined issues** - missions target specific and well-defined societal issues. They aim to foster innovation as a ‘by-product’ of solving a specific problem.

## Innovation during a crisis

Learning lessons from policies introduced in response to a crisis is not straightforward. Although achievements secured against a backdrop of war or

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<sup>7</sup> Mazzucato, M. and Willetts, D. (2019). A Mission-Oriented UK Industrial Strategy. UCL Institute for Innovation and Public Purpose, Policy Report, (IIPP WP 2019-04)., Available at: <https://www.ucl.ac.uk/bartlett/public-purpose/%20wp2019-04>

<sup>8</sup> Mazzucato M. (2018). Mission-oriented innovation policies: challenges and opportunities. *Industrial and Corporate Change*, 27(5):803–815, 2018.

<sup>9</sup> Mazzucato M. (2015), *Innovation Systems: From Fixing Market Failures to Creating Markets*; Intereconomics

<sup>10</sup> Mateos-Garcia, Juan C, *Mapping Research & Innovation Missions* (November 7, 2019). Available at SSRN: <https://ssrn.com/abstract=3483203>



pandemic, for example, are often remarkable, we must be realistic and acknowledge that these conditions are not replicable in ‘normal times’.

There is an existing literature on innovation during crisis that draws on rapid advancements in technology during the World War II, including mass-production of penicillin and the discovery of new anti-malarial drugs.<sup>11 12</sup> This cites some ‘exceptional’ factors that significantly sped up the process of innovation during a crisis. These include singularity of purpose among decision makers, increased coordination and cooperation, suspension of the normal bureaucratic process and focus on results and applied research. Consequently, we are mindful of the unique circumstances which led to the success of the Ox/AZ vaccine and take care to try and generalise lessons learned to make them relevant outside of crises. On the other hand, it is also important that governments do not rely on crises to catalyse missions and wait until it is too late.

## Stages of vaccine development

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Vaccine development is a long and complex process, often lasting 10-15 years and involving a combination of academic, private, and state actors.<sup>13</sup> The vaccine goes through a series of sequential stages in its development to test and establish its quality, safety, and efficacy. Challenges associated with using complex technologies and managing a variety of risks prolong the process. The standard stages of development and indicative timings for each are set out in **Figure 1**.

### Typical vaccine development process<sup>14 15</sup>

The length of the **drug discovery/exploratory stage** depends directly on the level of scientific difficulty and uncertainty involved in finding protective antigens of a specific pathogen. This research typically lasts anywhere from two to four years, as the process is complicated by, for example, mutating pathogens, challenges related

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<sup>11</sup> Gross D.P., Sampat B.N. (2021), *The Economics of Crisis Innovation Policy: A Historical Perspective*, NBER

<sup>12</sup> Quinn R. (2013), *Rethinking Antibiotic Research and Development: World War II and the Penicillin Collaborative*, American Journal of Public Health; <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3673487/>

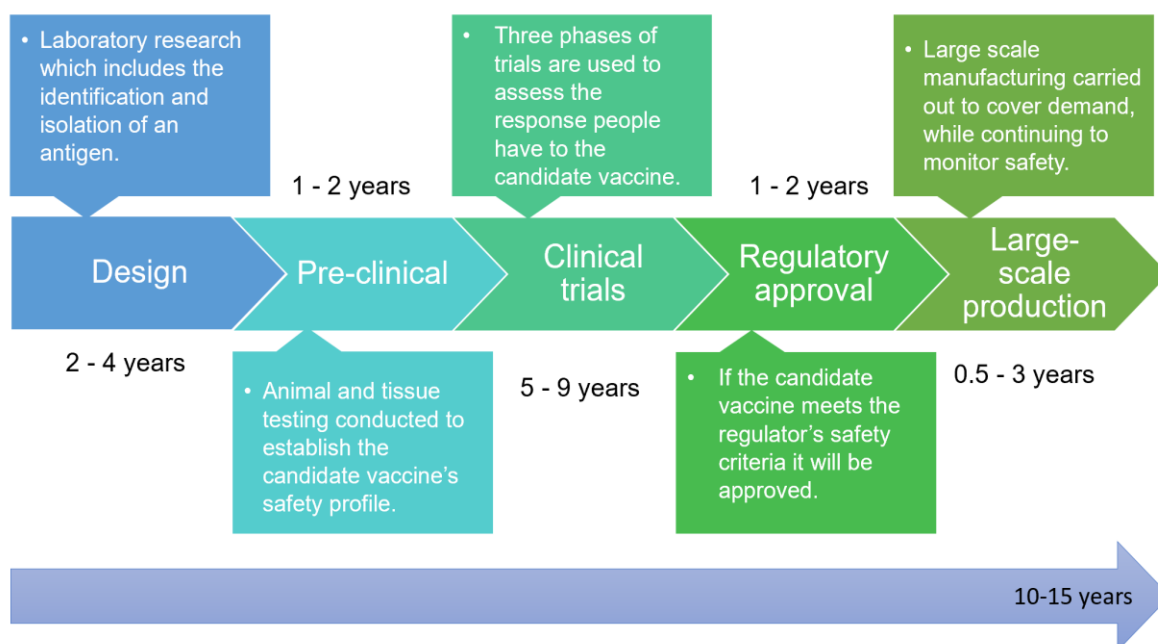
<sup>13</sup> International Federation of Pharmaceutical Manufacturers & Association (IFPMA). *The Complex Journey of a Vaccine: the steps behind developing a new vaccine*. [https://www.ifpma.org/wp-content/uploads/2019/07/IFPMA-ComplexJourney-2019\\_FINAL.pdf](https://www.ifpma.org/wp-content/uploads/2019/07/IFPMA-ComplexJourney-2019_FINAL.pdf)

<sup>14</sup> World Economic Forum (2020), *5 charts that tell the story of vaccines today*, Available at: <https://www.weforum.org/agenda/2020/06/vaccine-development-barriers-coronavirus/>

<sup>15</sup> Cabinet Office Briefing Rooms (2020), Available at: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/934360/Data\\_Briefing\\_Slides\\_11112020.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/934360/Data_Briefing_Slides_11112020.pdf)

to finding an appropriate delivery method or difficulties in activating an immune response.

Figure 1: Stylised timeline for typical vaccine development



Source: ISC based on International Federation of Pharmaceutical Manufactures & Association (IFPMA)

The **pre-clinical trial stage** often lasts around one to two years and is critical for proceeding onto human clinical trials. Pre-clinical trials are conducted to determine the candidate vaccine's ultimate safety profile, and include animal testing and tissue-culture systems.

The most time-consuming stage of vaccine development is **clinical trials**. These typically take five to nine years. There are usually three phases of the trials, with each used to assess the response people have to the candidate vaccine. Clinical trials take time as they involve large numbers of volunteers willing to test the new vaccine, and a process of trial and error based on emerging information on the safety and efficacy of the product.

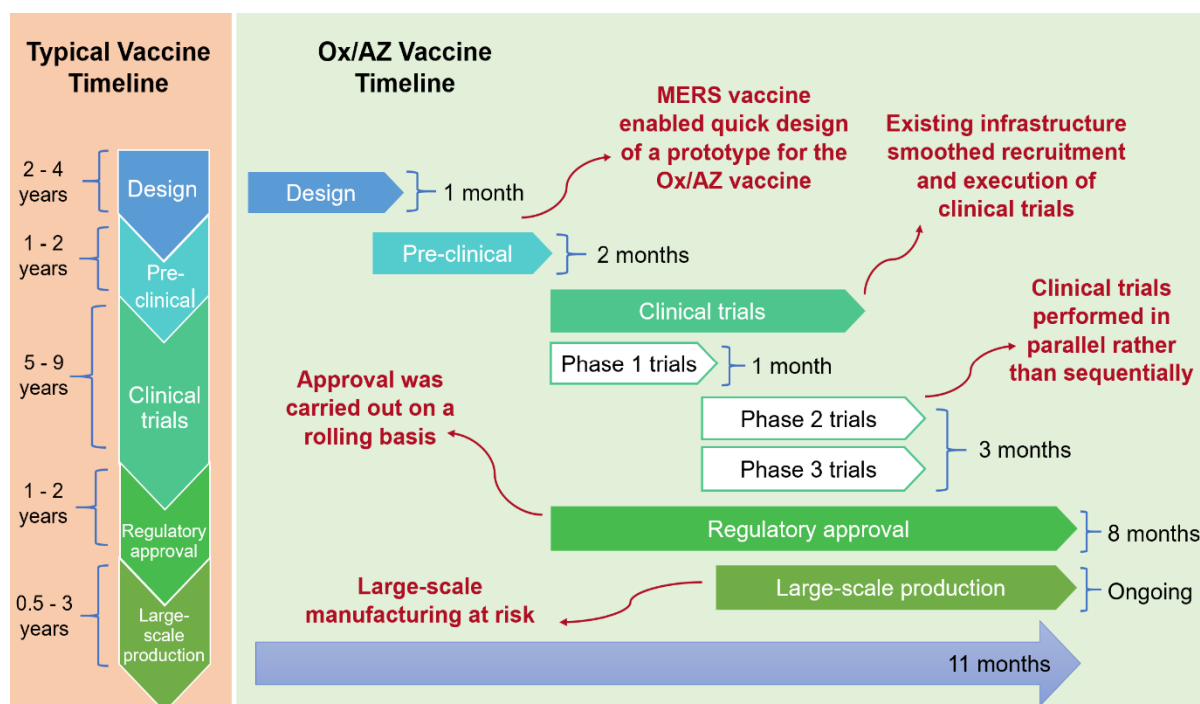
Following successful clinical trials, the new vaccine goes through the process of **regulatory approval**, usually taking one to two years. This is due to complex regulatory requirements, which might include, for example, reviews by ethics and biosafety committees.

Finally, once the vaccine has been approved, **large scale manufacturing** begins which normally takes between six months and three years to regularise, depending on available manufacturing capacity and complexities involved in scaling up batch sizes.

## Ox/AZ Covid-19 vaccine process

The Ox/AZ vaccine was developed and authorised within a year and its development process differed in many ways from the typical development process. Key time savings occurred at the discovery, clinical trial, and regulatory approval stages (**Figure 2**).

Figure 2: Process adaptations and time savings for the Ox/AZ vaccine development timeline



**The discovery stage** took weeks rather than years as scientists at Oxford were able to leverage technologies developed pre-pandemic. As soon as the genetic sequence for the Covid-19 virus became available January 2020, the Oxford vaccine team moved quickly to design a prototype of its vaccine. This was made possible by technical expertise and clinical data gained from development of a vaccine against another coronavirus, the Middle Eastern Respiratory Syndrome (MERS).<sup>16</sup>

The Oxford team were able to start **clinical trials** much earlier than usual and run phases two and three in parallel. Volunteers' willingness to take part in the trials played a crucial role in accelerating this phase, alongside existing clinical trial infrastructure.<sup>17</sup>

The **regulatory approval** process took place alongside clinical trials and ran for approximately eight months in total. Approval was granted through the emergency

<sup>16</sup> British Medical Journal (2021), *How the Oxford-AstraZeneca covid-19 vaccine was made*, first published on 12 January 2021, Available at: <https://www.bmj.com/content/372/bmj.n86>.

<sup>17</sup> BEIS (Sept 2020), *Press release: 10,000 UK volunteers to take part in new COVID-19 vaccine trials*, Available at: <https://www.gov.uk/government/news/10000-uk-volunteers-to-take-part-in-new-covid-19-vaccine-trials>.

procedure under Regulation 174 of the Human Medicine Regulations 2012.<sup>18</sup> Among other things, this facilitated the use of rolling, rather than sequential, reviews of clinical trial data.

The **manufacturing** of the vaccine was expedited by early government decisions to guarantee future orders, as well as by direct investments supporting the expansion of production capacities.

## Case study: Mission-oriented industrial policy and the development of the Ox/AZ vaccine

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In April 2020, the Government set three missions for the VTF. The most pressing was to “Secure access to the most promising [Covid-19] vaccine/s for the UK population as quickly as possible” (subsequently referred to as the ‘vaccine mission’).<sup>19</sup> The VTF responded by securing supplies of a portfolio of vaccine candidates, to minimise the risk of any single candidate failing. The unprecedented nature of Covid-19 also meant it had a role to play in developing vaccines.

This section explores how the Government’s vaccine mission helped accelerate the development of candidate vaccines. Using the Ox/AZ vaccine as a case study, we concentrate on how the VTF’s mission-based approach supported compressing development to under a year. We also use the case study to explore the factors that were a prerequisite for success.

### **A strong foundation in life-sciences and specific expertise in coronavirus vaccines built over many years were the foundations for success.**

The foundations for development of the Ox/AZ vaccine were built over many years with input from successive governments. The UK’s strong life sciences sector, deep expertise in vaccine technologies at the University of Oxford’s Jenner Institute and a high-quality institutional framework all helped expedite the development process.<sup>20</sup> Targeted public investment over the decade leading up to the pandemic played a

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<sup>18</sup> BEIS (Dec 2020), *Press release: Oxford University/AstraZeneca COVID-19 vaccine approved*, Available at: <https://www.gov.uk/government/news/oxford-universityastrazeneca-covid-19-vaccine-approved>.

<sup>19</sup> The other two missions were to ‘Make provision for international distribution of vaccines so that the benefits of UK leadership and investment in this area could be widely shared’ and ‘Support the UK’s Industrial Strategy by establishing a long-term vaccine strategy to prepare the UK for future pandemics’. See: Vaccine Task Force (2020), *UK Vaccine Taskforce 2020: achievements and future strategy*, Available at: <https://www.gov.uk/government/publications/uk-government-vaccines-taskforce-vtf-2020-achievements-and-future-strategy>

<sup>20</sup> University of Oxford (2020) *About the Oxford COVID-19 vaccine*, viewed February 2021, Available at: <https://www.research.ox.ac.uk/Article/2020-07-19-the-oxford-covid-19-vaccine>.

role in cultivating expertise in these areas. Longevity was crucial to compounding the benefits.

Successive governments have recognised the strength of UK life sciences and supported the industry, with a specific focus on vaccine development:

- The Cell and Gene Therapy Catapult, launched in 2012, has fostered expertise in vaccine delivery methods by helping firms and scientists translate early-stage research into commercially viable and investable therapies. This included work on viral vector and mRNA vaccine technologies.<sup>21</sup>
- In 2015, the UK Vaccine Network (UKVN) was established with £120m in funding.<sup>22</sup> The UKVN brings together government<sup>23</sup>, industry, academia, and relevant funding bodies (Innovate UK, Research Councils) to make targeted investments in specific vaccines and vaccine technology. UKVN's list of priority pathogens included another member of the coronavirus family, MERS.<sup>24</sup>
- The 2017 Industrial Strategy itself pledged to invest £66 million (via UK Research & Innovation) in the Vaccine Manufacturing and Innovation Centre UK (VMIC) which aimed to find ways of accelerating the vaccine manufacturing process.<sup>25</sup> VMIC was rapidly scaled up by the VTF after the outbreak of the pandemic and has now become a cornerstone of the Government's strategy to secure the supply of vaccines in the long term.<sup>26</sup>
- Life Sciences Sector Deals, negotiated on the back of the 2017 Industrial Strategy, committed £475m for R&D in the wider sector, including £16m to develop manufacturing capacity for the viral vector method of vaccine delivery.<sup>27</sup>

These government interventions can be traced through as contributing factors to the success of the Ox/AZ vaccine. For example, sustained government investment in

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<sup>21</sup> Oxford BioMedica (2017), Press release: Oxford BioMedica announces a £2 million two-year collaboration co-funded by Innovate UK, viewed February 2021, Available at: <https://www.oxb.com/news-media/press-release/oxford-biomedica-announces-%C2%A32-million-two-year-collaboration-co-funded>.

<sup>22</sup> Gov.uk, *UK Vaccine Network*, viewed February 2021, Available at: <https://www.gov.uk/government/groups/uk-vaccines-network>.

<sup>23</sup> The Department for Health and Social Care, Department for Business, Energy and Industrial Strategy, and the Office for Life Sciences.

<sup>24</sup> UK Vaccines Network (2019); *UK vaccines network: Mapping priority pathogens of epidemic potential and vaccine pipeline developments*; Conference Report

<sup>25</sup> BEIS (2018); Press release: Industrial strategy delivers new vaccines manufacturing centre to lead the fight against deadly disease; Available at: <https://www.gov.uk/government/news/industrial-strategy-delivers-new-vaccines-manufacturing-centre-to-lead-the-fight-against-deadly-disease>.

<sup>26</sup> BEIS (2020); Press release: *Vaccines Manufacturing and Innovation Centre to open 12 months ahead of schedule*, Available at: <https://www.gov.uk/government/news/vaccines-manufacturing-and-innovation-centre-to-open-12-months-ahead-of-schedule>

<sup>27</sup> Gov.uk, *Funding competition: Viral vector production to cell and gene therapies*, Available at: <https://apply-for-innovation-funding.service.gov.uk/competition/76/overview>

vaccines expertise helped compress the early stages of the Ox/AZ development process. The Department for Health and Social Care (DHSC) and Medical Research Council have funded MERS-related research since 2015 through the UKVN. This included trials of a MERS vaccine developed by the team at the Jenner Institute.<sup>28</sup> Data and experience gathered during those trials were a critical launchpad for Oxford scientists to begin work on the Covid-19 vaccine. In addition, links forged between academia and industry through the Cell and Gene Therapy Catapult helped build up capability in developing and manufacturing the viral vector technology used in the Ox/AZ vaccine.<sup>29</sup>

The UK life sciences sector, a recipient of two sector deals, was another pivotal contributor. It helped scale up vaccine manufacturing capacity. Prior to the pandemic the UK was reliant on vaccine imports, with a single plant in Liverpool for making seasonal flu vaccines and another in Scotland making Japanese encephalitis vaccine.<sup>30</sup> The Bioindustry Association (BIA), a life sciences industry body, laid the groundwork for increasing manufacturing capacity. As early as March 2020 it carried out a UK manufacturing capability audit which assessed UK capability to rapidly scale up any vaccine candidates and COVID-19 therapies.<sup>31</sup> This information helped set up collaborations, some of which involved the Cell and Gene Therapy Catapult and VMIC, to scale up the work being done at the Jenner Institute.<sup>32</sup>

Manufacturing and distribution capabilities were further enhanced through the partnership between the University of Oxford and AstraZeneca. The opportunity to partner with a UK company was crucial to securing the domestic supply chain for the Ox/AZ vaccine, as insurance against any complications with international supply chains. In addition, AstraZeneca's agreement to produce the vaccine at cost shows how government investment and academic assets (Oxford's vaccine technology in this case) can be used to ensure the return on government interventions targeting the private sector accrues to the general public.

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<sup>28</sup> DHSC (2019), Projects supported by DHSC through the UK Vaccine Network, Available at: [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/827983/projects-currently-being-funded-by-ukvn.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/827983/projects-currently-being-funded-by-ukvn.pdf).

<sup>29</sup> HJS (2020); *A bright future for genomics and gene therapy in the UK*, viewed February 2021, Available at: <https://www.hsj.co.uk/service-design/a-bright-future-for-genomics-and-gene-therapy-in-the-uk/7028207.article>

<sup>30</sup> Cookson C. in: The Financial Times (10 February 2021) *How the UK boosted its vaccine manufacturing capacity*, Available at: <https://www.ft.com/content/662ab296-2aef-4179-907c-5dba5c355d86>.

<sup>31</sup> UK Bioindustry Association (2020), *Press release: BIA industry-led vaccine manufacturing group welcomes funding announcement of £14m from UK government, to help rapidly scale up COVID-19 vaccines*, Available at: <https://www.bioindustry.org/news-listing/bia-industry-led-vaccine-manufacturing-group-welcomes-funding-announcement-of-14m-from-uk-government-to-help-rapidly-scale-up-covid-19-vaccines.html>.

<sup>32</sup> UK Bioindustry Association (2020), *Press release: BIA responds to Government investment of £20 million for coronavirus research*; Available at: <https://www.bioindustry.org/news-listing/bia-responds-to-government-investment-of-20-million-for-coronavirus-research.html>.

Finally, UK public sector institutions provided a fertile environment for developing, trialling, and authorising new vaccines. The National Institute for Health Research (NIHR) played an important role in organising Covid-19 vaccine clinical trials at pace for the Ox/AZ vaccine, drawing on its Clinical Research Network to attract participants and help administer the trials.<sup>33</sup> The Medicines and Healthcare products Regulatory Agency (MHRA) was also central, safely streamlining the process for undertaking clinical trials and granting regulatory approval.

**A clear mission, pursued with urgency at the most senior levels in Government, encouraged policy coordination and provided focus for ministers and officials.**

The clarity of the vaccine mission, and the urgency with which it was pursued at the highest levels of Government, expedited the Ox/AZ vaccine development process. Lines of accountability flowing directly from the Prime Minister placed a premium on policy coordination across traditional silos and opened the option of recruiting specialist expertise. In response to the mission, ministers and senior officials innovated, putting in place measures to make government decision-making timelier and more responsive to the needs of non-governmental partners. This included:

- **Remoulded bureaucracy and improved coordination across Government centred on the mission:** Government focus on the vaccine mission was reflected in the formation of a dedicated unit set up to support successful delivery. In 2020 the VTF comprised over 200 staff drawn from across government as well as external experts. It was led by a small steering committee drawn mainly from outside government, which focused on procuring vaccines, investing in UK manufacturing capacity, building clinical trial capacity alongside the National Institute for Health Research, coordinating with MHRA on licensing and regulation and with NHS England on deployment. The VTF strengthened government capacity by complementing civil service knowledge of government processes with industry expertise. The structure encouraged rapid dissemination of information and timely, coordinated inputs from key departments.<sup>34</sup>
- **Simplified government processes to support timely decisions:** A ministerial panel was created alongside the VTF, consisting of the Secretaries of State for Business, Energy and Industrial Strategy (BEIS) and DHSC, as well as the Chief Secretary to the Treasury and Minister of State in the Cabinet Office.<sup>35</sup> Bringing together these ministers into a single group sped up the process of ministerial sign-off. Under normal circumstances each minister

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<sup>33</sup> National Institute for Health Research, *Prioritised support for urgent COVID-19 research*, viewed February 2021, Available at: <https://www.nihr.ac.uk/covid-19/prioritised-support-for-urgent-covid-19-research.htm>.

<sup>34</sup> UK Vaccine Taskforce (2020), *UK Vaccine Taskforce 2020: achievements and future strategy*; Available at: <https://www.gov.uk/government/publications/uk-government-vaccines-taskforce-vtf-2020-achievements-and-future-strategy>

<sup>35</sup> NAO (2020), *Investigation into preparations for potential COVID-19 vaccines*; Session 2019-2021; published on: 16 December 2020

would have been consulted individually and sequentially. As the Chair of the VTF remarked, “We have four very senior ministers who are the decision makers. That was one of the reasons why we were able to be quick. If I called and said we need to have a decision on this in 24 hours, we had a decision in 24 hours. I think that is unusual.”<sup>36</sup>

The clarity of mission also led to a simplification of processes at working level. For example, HM Treasury (HMT) increased BEIS’s delegated spending limit (below which spending does not require HMT sign-off) from £70 million to £150 million per individual investment.<sup>37</sup> Interviewees also pointed to the clarity of senior ministers’ priorities and the urgency of the situation enabling greater autonomy of decision-making in day-to-day activities. The cumulative effect of these innovations and changes was, amongst other things, to reduce the time taken to make investment decisions relating to the VTF from four weeks to between seven and nine days.<sup>38</sup>

- **Recruiting specialist expertise into government:** There was early recognition that expertise from outside the civil service would be required. The Vaccine Expert Advisory Group (VEAG) was critical to bringing external expertise into government process and laying the groundwork for the subsequent establishment of the VTF.<sup>39</sup> Interviewees remarked on the importance of the skills mix on the VTF. Members from the private sector challenged existing processes, as well as supplying knowledge of vaccines and industry contacts to quickly solve problems. Civil servants complemented this with a knowledge of government process, especially around public spending. Housing the mixture of specialisms in a single organization (the VTF) was also crucial to fostering a common understanding of governmental and industry challenges to be overcome.

These measures enabled the VTF to develop different relationships with vaccine developers compared to a standard procurement process. For Oxford and AstraZeneca in particular, the VTF’s range of expertise allowed it to become a co-creator of solutions to overcome development challenges. Oxford’s relationship with government was initially owned by DHSC but shifted to the VTF on its establishment. The VTF was better placed to expedite governmental process and deploy expertise in support of Oxford scientists, which proved crucial to expediting stages of the development process such as clinical trials.

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<sup>36</sup> di Stefanie Bolzen , Antonello Guerrero (2021), *Kate Bingham: Why UK strategy on Covid vaccines has been a great success*, in: *la Repubblica*, Available at: [https://www.repubblica.it/cronaca/2021/02/07/news/kate\\_bingham\\_interview\\_vaccines\\_covid\\_astrazeneca\\_uk\\_coronavirus\\_johnson-286384093/](https://www.repubblica.it/cronaca/2021/02/07/news/kate_bingham_interview_vaccines_covid_astrazeneca_uk_coronavirus_johnson-286384093/)

<sup>37</sup> NAO (2020), pg. 11, op. cit.

<sup>38</sup> *ibid.*

<sup>39</sup> Public Accounts Committee (2021), *Formal meeting (oral evidence session): COVID-19: Planning for the vaccine (part 1), transcript* pg. 49., Available at: <https://committees.parliament.uk/event/3128/formal-meeting-oral-evidence-session/>



In addition, the benefits of a clear mission were felt beyond the purview of central government. For instance, it helped expedite the vaccine authorisation process while maintaining safety standards. The most important manifestation of this was the MHRA's decision to approve the vaccine under Regulation 174 of the Human Medicine Regulations 2012. This enables rapid emergency regulatory approvals to address significant public health issues such as a pandemic, and was updated by government in 2020 to make it suitable for responding to the Covid-19 pandemic.

The mission shaped behaviour more generally, encouraging co-operation between the MHRA and pharmaceutical companies. The MHRA agreed to assess data from clinical trials on a rolling basis, rather than at their conclusion. This allowed regulators to begin familiarising themselves with the data and conducting analysis at an earlier stage than usual, meaning a decision based on the complete dataset could be reached sooner.<sup>40</sup> The MHRA also embedded staff with the pharmaceutical companies to ensure bureaucratic delays, such as incorrect data formatting, were kept to a minimum. The result was a process that can last up to two years following completion of clinical trials was undertaken within eight months, and performed concurrently with clinical trials, ensuring the Ox/AZ vaccine played a major role in fulfilling the vaccine mission.

### **Large-scale financial commitments from government reduced risks for Oxford and AstraZeneca to manageable levels.**

The Government's willingness to take substantial financial risks in pursuit of its vaccine mission was critical to the Ox/AZ vaccine being developed and manufactured in the UK, as well as its delivery within a year. The Government made a large, advanced order of doses of the Ox/AZ vaccine prior to evidence of its efficacy, which encouraged manufacturing at risk.<sup>41</sup> It also provided an indemnity against some adverse potential impacts, funded clinical trials, and invested in scaling up manufacturing capability. Despite the possibility of a material loss of public funds if the vaccine had proven unsafe or ineffective, the case for accepting these risks was overwhelming given the benefits associated with vaccinating the population sooner.

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<sup>40</sup> Gov.uk, *Guidance: Rolling review for marketing authorisation applications*, viewed February 2021, Available at: [/www.gov.uk/guidance/rolling-review-for-marketing-authorisation-applications#:~:text=The%20rolling%20review%20is%20a,a%20consolidated%20full%20dossier%20submission.](https://www.gov.uk/guidance/rolling-review-for-marketing-authorisation-applications#:~:text=The%20rolling%20review%20is%20a,a%20consolidated%20full%20dossier%20submission.)

<sup>41</sup> NAO (2020), op. cit.

*Box 1: Advanced market commitments*

**Advanced Market Commitments help to fix market failures in vaccine supply**

The value of advanced market commitments (AMCs) for vaccines is well established. The risks involved in researching and manufacturing vaccines are large, particularly when using new technologies, which can lead to distortions in the vaccines market. For example, vaccines against certain diseases are prohibitively expensive for some in low-income countries that are most in need, or the risks are so great that development is not pursued at all.

AMCs are designed to provide guaranteed demand for an effective vaccine at a price agreed in advance, in order to bolster Research & Development (R&D) and manufacturing incentives.<sup>42</sup> This 'pull' funding supplements direct R&D support, expediting the development process. For vaccines further along the R&D process, the certainty given by AMCs incentivizes scaling up production capacity to meet the needs of the population. The agreement of a purchase price up front ensures the vaccine is affordable according to the needs of the government or donor that is funding the AMC.

The VTF's advanced order of 100 million doses of the Ox/AZ vaccine in May 2020 significantly de-risked development of the vaccine for AstraZeneca.<sup>43</sup> In a move that amounted to an AMC (see **Box 1** for more information) the Government guaranteed demand at a pre-arranged price<sup>44</sup>, while the size of the Ox/AZ vaccine order supported its development in the UK. An up-front payment, some of which was non-refundable in the event of failure, was an important signal of the Government's commitment to the vaccine's development. It provided vital working capital with which to scale manufacturing processes and ensured manufacturing at scale began in advance of regulatory authorisation.

The Government directly funded parts of the development process to de-risk it further for Oxford and AstraZeneca, and help them concentrate on speed, efficacy and safety. UK Research & Innovation and DHSC provided joint funding of £400,000 in early 2020. This supported Oxford's efforts in conjunction with an industry consortium (prior to AstraZeneca's involvement) to scale the size of vaccine batches in readiness for clinical trials. The VTF secured a further £20 million to fully fund

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<sup>42</sup> Kremer M., Levin J., Snyder C. M. (2020), *Advance Market Commitments Insights from Theory and Experience*, Stanford Institute For Economic Policy Research, Working Paper No. 20-008

<sup>43</sup> *Ibid.*

<sup>44</sup> NAO (2020), pg. 23, op. cit.

clinical trials of the Ox/AZ vaccine, further mitigating the risks of operating at pace for AstraZeneca.<sup>45</sup>

Government financial support was also crucial to enhancing domestic vaccine manufacturing capacity to produce the Ox/AZ vaccine in the UK. Neither Oxford nor AstraZeneca had large-scale vaccine manufacturing experience. The VTF helped set up production partnerships with Oxford BioMedica and Cobra Biologics. The VMIC also supplied Oxford BioMedica with manufacturing equipment to help scale up the production of the Ox/AZ vaccine. While Wockhardt's Wrexham plant was identified as a potential fill-finish site, with the VTF signing a contract to secure supply for the Ox/AZ vaccine production process.<sup>46</sup>

The consequences of the Government declining to take these risks would most likely have been the Ox/AZ vaccine being developed at a slower pace or even elsewhere. The Chair of the VTF testified to Parliament that several countries were exploring ways of effectively procuring vaccine supplies.<sup>47</sup> Given the extraordinary circumstances under which development was taking place, a more cautious approach to risk-sharing would have seen the UK lose its first-mover advantage when procuring the vaccine.

## Lessons for UK industrial policy from the Ox/AZ vaccine case study

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The development of the Ox/AZ vaccine as part of the UK's vaccine procurement programme demonstrates how missions can be a valuable part of the supply-side policy toolkit. In this section we join relevant parts of the mission-oriented policy framework with our findings from the Ox/AZ vaccine case study, to draw some general lessons for future industrial policy.

To make our lessons actionable, we consider which parts of the government's vaccine mission are replicable without the urgency of a global pandemic. We also explore the conditions under which government missions are likely to be most effective.

### **Lesson 1: Choose a small number of clear, measurable missions and make them a priority at the highest levels of government.**

The clarity and urgency of the vaccine mission remoulded government bureaucracy and smoothed policy coordination, which shortened the timeline for developing the

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<sup>45</sup> Morriss E. (2020), *Government launches coronavirus vaccine taskforce as human clinical trials start*, in: Pharmafield, Available at: [https://pharmafield.co.uk/pharma\\_news/government-launches-coronavirus-vaccine-taskforce-as-human-clinical-trials-start/](https://pharmafield.co.uk/pharma_news/government-launches-coronavirus-vaccine-taskforce-as-human-clinical-trials-start/).

<sup>46</sup> Cookson C. in: *The Financial Times* (10 February 2021) op. cit.

<sup>47</sup> Public Accounts Committee (2021), op. cit.

Ox/AZ vaccine. The Government should seek to replicate this for other pressing industrial policy challenges.

Within government, a well-defined mission can support ministers and senior officials to innovate, by creating structures dedicated to achieving the objective and simplifying processes. This facilitates working across departmental silos and helps provide the policy longevity and consistency required to effect structural changes. The clarity of the mission and the resulting process innovation within government can also focus the efforts of non-governmental actors and facilitate cooperation.

Missions are unlikely to succeed unless they are sponsored at the highest levels of government. It is not possible or desirable to replicate the urgency of the vaccine mission. Working at the pace required to deliver the Ox/AZ vaccine is not sustainable outside of a crisis. Nevertheless, having the Prime Minister and members of the Cabinet holding progress against the mission to account provides momentum and the impetus to innovate, and is replicable in 'normal times'.

Missions should be deployed sparingly. A limited number of missions ensures they remain a priority at the highest levels of government. In addition, many policy challenges do not lend themselves to a mission-based approach, because the potential benefits are not large enough to justify the resources required.

### **Lesson 2: Map out an end-to-end path to success.**

Findings from our case study show that government played a role at every stage of the Ox/AZ vaccine supply chain which supported crucial time savings. The absence of government involvement at any stage would have delayed development. This underlines the importance of mapping out an end-to-end path to success for missions, to recognise key dependencies, highlight obstacles and help identify actors that need to be involved.

Recognising and understanding end-to-end supply chains is a lesson applicable to UK industrial policy beyond just missions. The case study is pertinent example. Historically, the UK has not realised the full benefits of its position as a global leader in academic research, due to a relative weakness in translating research into commercial products.<sup>48</sup> Consequently, the UK was well-placed to invent a vaccine, but manufacturing capacity had to be built up quickly to capitalize on this. Ensuring industrial policy interventions are conceived with end-to-end supply chains in mind guards against a weak link undermining returns on investment.

### **Lesson 3: Harness the public, private and voluntary sectors in co-creating and delivering industrial policy.**

Development of the Ox/AZ vaccine inside a year was made possible by combining a range of skillsets. Scientists, venture capitalists, manufacturing experts, regulators, civil servants and volunteers all contributed at different stages of the supply chain.

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<sup>48</sup> RSM PACEC LTD (2018), *Research into issues around the commercialisation of university IP*, A report for the Department for Business, Energy and Industrial Strategy

The success of this multi-faceted approach demonstrates the value in industrial policy harnessing the skills of the public, private, and voluntary sectors, consistent with their respective comparative advantages.

Co-creation and co-delivery, principally through the VTF, was also critical to delivering the Ox/AZ vaccine successfully. The VTF was led by a venture capitalist and built on planning undertaken outside of government by the BIA's industry consortium. This was central to identifying potential manufacturing bottlenecks and enabled government and industry to co-create and co-fund solutions. Expediting the Ox/AZ clinical trials involved co-ordination between public health bodies, regulators, scientists, industry and volunteers, supported by civil servants working to secure timely funding to de-risk the process for Oxford and AstraZeneca.

#### **Lesson 4: Use strategic procurement and financial insurance to drive progress against industrial policy objectives.**

The Government's willingness to commit public money at scale towards de-risking the Ox/AZ vaccine development process for Oxford and AstraZeneca was critical to success. In future, the Government should be willing to assume risk from partners through strategic procurement and providing financial insurance, where it will materially enhance the chances of overcoming policy challenges.

The Ox/AZ vaccine case study alone shows that government can assume financial risks in a variety of ways for differing purposes. For example, AMCs guaranteed demand at a fixed price, reduced uncertainty across the supply chain, and stimulated supply. Up-front payments, indemnities and direct funding also smoothed the production process. For the VTF more generally, its portfolio diversification strategy showed how to insure against risks to the public purse associated with picking winners.

This approach lends itself to mission-oriented policy. It is likely to work best for issues of significant societal or economic importance, where the market alone will not deliver solutions fast enough or even at all. Large potential benefits mean that, across a portfolio of projects, the pay-off from a few successful projects is likely to outweigh losses from the failed ones.

A robust cost-benefit framework through which to identify appropriate risks to take is key. It is unrealistic to expect the benefits from solving future policy challenges to be as large and obvious as was the case for developing a Covid-19 vaccine, and high-profile failures can undermine the public's trust in this approach. Therefore, robust methods are needed to identify priority projects. Equally, proponents of mission-oriented policy have advocated moving beyond standard cost-benefit methods to

capture the full range of benefits from policies that not merely fix but also create and shape markets.<sup>49</sup>

### **Lesson 5: Provide long-term investment at scale as part of sector strategies to maximise the UK's industrial, commercial and technological strengths.**

The case study illustrates the importance of cultivating industrial, commercial, and technological strengths. The foundations for successful development of the Ox/AZ vaccine lay in the UK's comparative advantage in life sciences and especially vaccines. This comparative advantage is, in part, the result of investment at scale by successive governments, including as a component of the 2017 Industrial Strategy. More strategic investment in areas such as commercialisation would have smoothed the process further.

The centrality of strong life sciences to the Ox/AZ vaccine success is an example of how persistent investment in core strengths generates value for the economy. The ISC has pointed out previously that the pursuit of policies and economic goals built on an in-depth understanding of domestic strengths and weaknesses is a feature of industrial strategies in other developed economies.<sup>50</sup> This is particularly relevant in relation to technologies and industries that are widely expected to drive economies globally over coming years, and where the UK still has the opportunity of capturing a significant share of the global market.

The case study also emphasises the importance of viewing industrial policy as more than simply targeting investment. For example, the quality of the institutional architecture is critical. A highly respected regulator, established infrastructure for conducting clinical research, and organisations promoting industry-academia cooperation (Catapults) all played a vital role in developing the Ox/AZ vaccine.

### **Lesson 6: Build resilience as part of industrial policy**

The case study highlights the need to factor resilience into industrial policy. Gaps in manufacturing capacity that became apparent when the pandemic struck threatened the UK's ability to develop the vaccine domestically. This illustrates the wider importance of 'defensively' maintaining key parts of the UK's infrastructure, and in particular its manufacturing base, as a precaution against future crises. Risk minimisation must exist alongside maximising returns as a criterion for choosing how and where supply-side support for the economy is directed.

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<sup>49</sup> Mazzucato, M. and Willetts, D. (2019). A Mission-Oriented UK Industrial Strategy. UCL Institute for Innovation and Public Purpose, Policy Report, (IIPP WP 2019-04). Available at: <https://www.ucl.ac.uk/bartlett/public-purpose/wp2019-04>

<sup>50</sup> Industrial Strategy Council (2020), *Effective Policy Approaches to Sectoral Issues*, Research paper