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Fostering SME supplier-enabled innovation in the supply chain: The role of innovation policy

Abstract

Buying organisations collaborate with their suppliers to innovate, and increasingly seek to tap into the innovation potential of technologically-adept small and medium-sized enterprises (SMEs) who are new to them. Engagement with technology-based SMEs as possible suppliers can be constrained by institutions (e.g. rules, regulations and norms of conduct) embodied in the buying organisation's procurement and supply chain strategy, processes and practices. Although prior research has examined how institutional forces influence supplier-enabled innovation, little is known about institutional failures that are particularly germane to innovative SMEs and impede collaboration between these SMEs and buying organisations. Consistent with the focus of the second Emerging Discourse Incubator (EDI) on researching the effects of institutions (e.g. regulations) and public policies on supply chains, we investigate how enacted innovation policies address SME-specific institutional failures in a public sector context, that of the English National Health Service (NHS). Our qualitative research reveals that public agencies responsible for policy enactment seek to promote SME supplier-enabled innovation in the supply chain through institutional change and mitigation, SME connectivity to supply chain actors, and SME supplier development support. We synthesise our findings into a research model and set of propositions which theorise on the specific mechanisms underpinning the interventions of policy-enacting agencies and their effects. Our study contributes to the literature on supplier-enabled innovation and to research focusing on collaboration between buyers and innovative small suppliers. More broadly, we generate theoretical insights regarding the role of public agencies enacting policy as a class of non-firm actors whose interventions influence the supply chain. The findings also add to our understanding of the interplay between supply chains and institutions.

Keywords: supplier-enabled innovation; small and medium-sized enterprises; innovation policy; institutions; supply chains; public sector

INTRODUCTION

In an era of continuing specialisation and fast technological change, buying organisations collaborate with their suppliers to innovate (Arjbjørn & Paulraj, 2013; Sharma et al., 2020). Engagement with suppliers provides specialised technical knowledge and novel ideas (Johnsen, 2009), and helps buyers to improve their innovation performance (Suurmond, Wynstra & Dul, 2020). In addition to collaborating with their existing suppliers, buying organisations increasingly seek to tap into the innovation potential of technologically-adept firms who are new to them, including small firms (Chae, Yan & Yang, 2020; Legenvre & Gualandris, 2018). Technology-based small and medium-sized enterprises (SMEs) are an important source of innovation (Narasimhan & Narayanan, 2013), because their entrepreneurial drive, agile governance structures and flexibility allow them to respond fast to unmet customer needs and disruptive technological trends (Zaremba, Bode & Wagner, 2016), and to supply novel products, services and critical R&D inputs.

Engagement and collaboration with innovative small firms is challenging, though (Moschner et al., 2019). SMEs often lack the funding, social capital, capabilities and market legitimacy required (Kull, Kotlar & Spring, 2018). Buying organisations, on the other hand, must have capabilities in supplier evaluation, supplier development and relationship management, tailored to fit the innovative firms' limitations (Zaremba, Bode & Wagner, 2017). However, buying organisations may not be able to develop these customised capabilities, not least due to institutional constraints (Bruce, de Figuieredo & Silverman, 2019). Institutions include rules, regulations and norms of conduct (North, 1990). We refer to deficiencies in institutions that impede innovation (Edquist & Johnson, 1997; Tokar & Swink, 2019) as institutional failures. These are especially important in public organisations, and are embodied in their procurement and supply chain strategies, processes and practices (Rolfstam, 2013). Examples of institutional failures include rigid rules that emphasise standardisation in

innovation sourcing and supplier management, as well as conservative attitudes and norms of procurement professionals. Such failures are often exacerbated by SMEs' financial, capability or social capital limitations. For instance, procurement managers can be more risk-averse when it comes to engaging with innovative SMEs lacking proven capabilities and market reputation.

Institutional failures thus limit the ability of buying organisations and innovative SMEs to collaborate effectively. International evidence shows that, although public organisations and their first-tier suppliers can extract significant value from engagement with innovative SMEs in areas as diverse as national security, healthcare, sustainable transport and digital government, they are often unable to tap into SME innovations due to regulatory and cultural barriers (OECD, 2017; UK Government Central Digital & Data Office, 2018; U.S. Congressional Research Service, 2021). These challenges give rise to public policies aiming to promote SME-enabled innovation in supply chains (Mazzucato, 2015), but the inner workings of such policies remain elusive (Connell, 2017). Research on this issue generates policy impact by showing how public organisations can more effectively integrate SME innovations into their supply chains. By acting as first customers of SMEs' novel solutions, public organisations and their suppliers also help small firms to gain market legitimacy and grow (Harland et al., 2019).

Studies focusing on engagement with innovative small suppliers (Zaremba et al., 2016; 2017) downplay the role of institutions and emphasise instead the capabilities buyers need to develop. And although the broader literature on supplier-enabled innovation recognises the influence of institutional forces (e.g. Wang, Li & Chang, 2016), including in public sector settings (Rolfstam, 2013), it neglects institutional failures that are particularly germane to innovative SMEs, as well as how these failures could be addressed. Research has stressed the role that public policies play in creating the right institutional conditions to drive innovation in firms and supply chains (Spring et al., 2017). Innovation policy interventions are typically designed by government departments and enacted through specific programmes by public

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agencies responsible for their implementation (Edler & Fagerberg, 2017). Enacted policies seek to shape an institutional set-up (Edquist & Johnson, 1997) conducive to innovation e.g. by fostering collaboration (Dodgson et al., 2011). However, to date we know very little about how agencies enacting policies specifically seek to promote SME-enabled innovation in supply chains. In line with the focus of the second Emerging Discourse Incubator (EDI) on the effects of institutions (e.g. regulations) and public policies on supply chains (Fugate, Pagell & Flynn, 2019), we investigate policy interventions seeking to tackle institutional failures that hinder engagement between innovative SMEs and buying organisations. Specifically, our study seeks to answer the following research question: *How do enacted innovation policies address institutional failures specific to the engagement of innovative SMEs with buying organisations and foster SME supplier-enabled innovation in supply chains?*

We pursue this research question in the context of the English National Health Service (NHS). Rising demand (not least due to changing demographics) and resource limitations make supplier-enabled innovation imperative to the NHS, to increase service productivity and deliver affordable healthcare (Meehan, Menzies & Michaelides, 2017). Initiatives such as digital health and remote care give technology-based SMEs an important role in improving patient outcomes while reducing care costs (NHS England, 2019a). However, engagement with the NHS as a buying organisation is institutionally challenging (Rolfstam, Philips & Bakker, 2011), so particular policies to promote SME innovation in the NHS's supply chain have been introduced: Academic Health Science Networks (AHSNs) and the Small Business Research Initiative (SBRI). The former establishes regional health innovation agencies with a mission to spread innovation 'at pace and scale' (AHSN Network, 2019a). A core part of AHSNs' work is to support NHS engagement with innovative SMEs. The SBRI is the UK policy for public procurement of R&D, mainly targeting technology-based SMEs and start-ups. The two policies were originally designed by the UK Government Departments of Health and Social Care

(DHSC) and of Business, Energy and Industrial Strategy (BEIS) respectively, and subsequently enacted through specific programmes. The AHSN agency we studied, henceforth referred to as InnoMed, enacts policy through its Healthcare Business Connect (HBC) programme. Innovate UK, the national innovation agency, shares implementation responsibility with InnoMed (and other AHSNs) for the SBRI Healthcare programme, which enacts the SBRI policy specifically in the healthcare sector. Both programmes support technologically-adept SMEs as potential suppliers of innovations that fulfil the NHS's unmet needs. Figure 1 outlines the research setting. Our focus is on how SMEs participating in these programmes are helped by implementing agencies to engage with the NHS and its supply chain.

[Insert Figure 1 Approximately Here]

Our study contributes to research focusing on collaboration between buyers and innovative small suppliers (Zaremba et al., 2016; 2017), by showing that limits to engagement with innovative SMEs do not only result from buying organisations' lacking capabilities: institutional failure is also a critical factor, and impedes collaboration with technologically-adept SMEs. We develop empirical insights regarding various forms of SME-specific institutional failures, thereby also extending the literature on supplier-enabled innovation which highlights the influence of gross institutional characteristics at national level (e.g. Wang et al., 2016). We furthermore build on research stressing the role of public policies in promoting innovation in supply chains (Spring et al., 2017) and develop theory on how the agencies enacting innovation policies seek to address SME-specific institutional failures. More generally, we develop theoretical insights regarding the role of policy-enacting agencies as non-firm actors whose interventions influence the supply chain, in line with the call of this EDI (Fugate et al., 2019). The findings also add to our understanding of the interplay between supply chains and institutions (cf. Wu & Jia, 2018).

THEORETICAL BACKGROUND

Supplier-enabled Innovation and the Role of SMEs

Research on supplier-enabled innovation principally examines why and how focal buying firms use the capabilities of their suppliers to improve innovation performance (e.g. Koufteros, Cheng & Lai, 2007; Suurmond et al., 2020). Buying firms rely on their suppliers as sources of knowledge and novelty (Lawson, Tyler & Potter, 2015; Wowack et al., 2016) because of greater specialisation and faster change in technology (Sharma et al., 2020). These specialised capabilities of suppliers have been conceptualised using resource dependence and knowledge-based theories (Oke, Prajogo & Jayaram, 2013). However, to use a supplier's innovation potential, the buying firm must also have the absorptive capacity to identify and assimilate supplier capabilities and to integrate them with its own internal resources and know-how (Narasimhan & Narayanan, 2013). Beyond these characteristics of the supplier and buyer respectively, the supply network's structure and complexity also affect innovation processes and outcomes (Gao, Xie & Zhou, 2015; Sharma et al., 2020). Analyses informed by social network and social capital theories suggest that network accessibility and interconnectedness (Bellamy, Gosh & Hora, 2014) and structural equivalence of buyer and supplier positions within their networks (Chae et al., 2020) influence a focal firm's innovation performance.

Most of this research examines innovation with the buying firm's *existing* suppliers (e.g. Van Echtelt et al., 2008; Yan, Yang & Dooley, 2017); it also neglects SME suppliers. However, some recent studies suggest that buying firms also need to engage with new suppliers, including start-ups and innovative SMEs, when sourcing innovation (Zaremba et al., 2016; Legenvre & Gualandris, 2018). SMEs, who are defined by the size of their workforce[1],

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[1] The exact definition of SMEs varies internationally. In the U.S., an SME is a company with a maximum number of employees between 250 and 1,500, depending on sector (U.S. Small Business Administration, 2020). In Europe, SMEs are firms with fewer than 250 employees, having an annual turnover of up to EUR 50 million or a balance sheet total of up to EUR 43 million (European Commission, 2020). SMEs are significant economically because they represent the vast majority of all firms internationally, and account for more than half of total employment and economic value added (Kull et al., 2018).

play critical roles in many supply chains (Kull et al., 2018) and can be an important source of novel forms of technological expertise (Zaremba et al., 2017). Compared to large, established suppliers, SMEs are more flexible because they are organised less formally, and have agile governance structures and decision-making processes, which allow them to respond faster to changing customer needs (Kull et al., 2018). SMEs often have entrepreneurial founder-managers who are quick to identify and exploit market opportunities by coordinating firm resources to transform ideas into new products and services (Alvarez & Barney, 2004).

However, SMEs face significant limitations when compared to large, established suppliers. They do not have access to the same level of finance, human resources, and connections (Kull et al., 2018). They often lack routines to interact with their task environment, are deficient in particular capabilities (e.g. in manufacturing or distribution), and lack legitimacy and reputation in the marketplace (Zaremba et al., 2016). These limitations can make it harder for innovative SMEs to collaborate with buying organisations for innovation purposes (Moschner et al., 2019). At the same time, engaging with large buyers is attractive for innovative SMEs, since they can gain access to buying firms' resources and know-how to compensate for their aforementioned limitations (Zaremba et al., 2016).

To collaborate effectively with innovative SMEs, Zaremba et al. (2017) argue, a buying firm must adopt a distinctive approach and set of capabilities in terms of supplier assessment and development, supplier communication and relationship management. These could include customised supplier development interventions to fit the needs of innovative small firms e.g. in terms of training, and fast release of finance and other resources. However, while this research (Zaremba et al., 2016; 2017) identifies how buying firms could improve their ability to engage with innovative small suppliers, many buying organisations may not be able to develop capabilities tailored to accommodate SMEs' limitations. Public-sector organisations, particularly, are constrained because they must adhere, for instance, to regulations mandating

standardised contracting, transparency and competition (Bruce et al., 2019). In other words, the innovation sourcing efforts of buying organisations, especially in public sector settings, are limited by the institutional set-up in which they operate (Rolfstam, 2013).

Institutions and Supplier-enabled Innovation Processes

Institutions are 'the rules of the game' in society and economy, the humanly devised constraints that structure incentives and define and regulate interactions between individuals and between organisations (North, 1990). Institutions include both formal constraints such as laws, regulations, property rights, and standards, and informal ones e.g. culture, customs, routines, practices, norms of conduct, and behaviours (North, 1990; Williamson, 2000). Institutions affect innovation processes in general, and supplier-enabled innovation in particular.

In the operations management (OM), supply chain management (SCM) and related literatures, several studies of innovation in supply chains have addressed institutional forces, focusing on gross institutional differences between countries, and how these features affect performance in innovation sourcing. The institutional characteristics and differences examined include *guanxi,* and regulatory changes imposed by the Chinese state (Wang et al. 2016), weak intellectual property protection, again in China (Jean, Sinkovics & Hiebaum, 2014), and the distinctively strong property rights laws and enforceability of contracts in the U.S. (e.g. Bello, Lohtia & Sangtani, 2004; Yan & Nair, 2016). To overcome such institutional differences, large firms establishing supply chains in host countries seek to adapt to, but also to change, relevant rules, standards and norms of conduct (Wu & Jia, 2018), and may also leverage political ties to enhance their innovation performance (Jean, Sinkovics & Zagelmeyer, 2018).

The attention this literature gives to institutional effects on supplier-enabled innovation is welcome. However, such research sidesteps a number of important issues. First, by focussing on stark contrasts between very different national contexts, it tends to underplay the effects of

more everyday institutional differences that are salient within a particular geography, for example, the differences between the private sector – which dominates published research on supplier-enabled innovation in OM/SCM – and the public sector (Rolfstam, 2013). Second, this literature stream neglects institutional failures specific to innovative SMEs seeking to engage with a buying firm's innovation process. Research specifically on small-supplier-enabled innovation (Zaremba et al., 2016; 2017) downplays institutional aspects in favour of arguments based on firm-level capabilities. Third, studies that use survey approaches to examine institutional effects on innovation with suppliers (e.g. Jean et al., 2018) treat institutions as moderating variables, but are not concerned with how these institutional effects come about. Institutions operate through the strategy, processes and practices of firms and other, non-firm actors (e.g. public organisations) either individually or at the level of the supply chain. Institutions only affect outcomes through the 'transmission belt' of these individual, firm- and supply-chain level structures and processes; or, as Wu & Jia (2018, p. 40) put it, 'networks carry institutional effects'. A supply chain perspective is thus useful in helping us to understand how the institutional set-up interacts with the concrete activities of firms and other organisations in the innovation process. Since institutions can significantly restrict flexible approaches to innovation sourcing, especially in public sector settings (Bruce et al., 2019), we need to better understand what institutional failures may be particularly germane to SMEs seeking to engage with buying organisations, and how these failures could be addressed. Innovation policy interventions have an important role to play in this respect.

The Role of Innovation Policy

Governments design policies to overcome institutional failures, including those impeding innovation. Innovation policy is broadly defined as the sum of policies affecting innovation activity (Edler & Fagerberg, 2017) and overlaps significantly with related policy areas known

as industrial policy, research (or science) policy, and technology policy. It seeks to enable innovation in firms and supply chains by shaping a supportive institutional set-up e.g. through connecting actors, and facilitating learning and capability development (Spring et al., 2017).

In this paper, we examine how innovation policies, as enacted through programmes, address institutional failures specific to the engagement of innovative SMEs with buying organisations. During the course of our abductive research process, which is described in the next section, we found it useful to draw on the systems-of-innovation perspective (Edquist, 1997), one of the prevailing theoretical frameworks for innovation policy design and implementation (Edler & Fagerberg, 2017). We introduce the key elements of this perspective here. The systems-of-innovation approach is analytically useful because it emphasises the role of institutions in the innovation process (Edquist & Johnson, 1997), and suggests that enacted policies aim to create an institutional set-up conducive to innovation (Dodgson et al., 2011). It also stresses the collaborative and ever-evolving nature of the process of producing and using new knowledge (Schot & Steinmueller, 2018), viewing innovation as a systemic activity that takes place through inter-organisational interactions and learning (Lundvåll, 1992).

The systems-of-innovation approach suggests that innovation is obstructed by systemic failures, notably a lack of connectivity and cooperation among actors, capability shortfalls, institutional lock-in effects, or reluctance to adopt innovations (Dodgson et al., 2011; Mazzucato, 2015). Agencies charged with innovation policy implementation should thus aim to overcome these failures, and targeting institutions is the central mechanism for attaining this aim (Edquist, 1997). Institutions enable innovation by helping to reduce uncertainty, fostering collaboration, and channelling resources to innovation activity (Edquist & Johnson, 1997). However, institutions can also slow down or hinder innovation (Edquist & Hommen, 1999) insofar as institutional conditions such as regulatory frameworks fall behind technological or business model innovation, as the examples of ride-sharing platforms and autonomous vehicles

teach us (Tokar & Swink, 2019). Accordingly, agencies enacting policies seek to intervene in the institutional set-up, to address failures associated with regulatory voids, misaligned incentives, and norms and behaviours impeding experimentation with novel solutions and innovation adoption (Edquist & Hommen, 1999). Such interventions also enable interactions among seemingly diverse (public and private sector) actors, facilitate capability development, and incentivise collaborative R&D (Spring et al., 2017; Selviaridis, 2021).

The systems-of-innovation approach, however, is silent on how exactly policy-enacting agencies and other affected organisations (e.g. buying organisations or suppliers) interact with the institutional set-up. Institutional analysis (North, 1990) provides insights into how institutions affect organisations, and vice versa. Organisations are influenced by the institutional set-up they are embedded in, and its resulting structure of incentives (North, 1990). They also embody more general institutions (e.g. public procurement regulations) in their practices and norms, thus making such institutions more stable and enduring (Rolfstam, 2013). Organisations can thus elect to adapt their procurement and supply chain strategies and practices to the institutional forces at play (Davis-Sramek et al., 2017), or opt for more active responses (Oliver, 1991) e.g. by engaging in political activity to change institutions affecting their supply chains, or to create new ones, in line with their interests (Wu & Jia, 2018). Crucially, organisations seeking to influence and change the institutional set-up may also include non-firm actors such as public agencies responsible for policy implementation (cf. Fugate et al., 2019). To date, however, there has been very limited scholarly work focusing on how public agencies enacting innovation policies seek to address institutional failures specific to the engagement of innovative SMEs with buying organisations. Our study, grounded on a public sector setting, generates theoretical and empirical insights to this end.

RESEARCH METHOD

We adopted a qualitative, case-based research design (Barratt, Choi & Li, 2011), for two reasons. First, case study research is suitable for exploring contemporary phenomena and for asking open-ended, "how" questions while accounting for real-world settings and views and experiences of relevant actors (Voss, Tsikriktsis & Frohlich, 2002). Given the scant empirical research on SME-specific institutional failures, and on how enacted policies address such failures, the case study methodology allowed us to develop in-depth understanding of the role of policy-enacting agencies and their programmes in promoting SME-enabled innovation in the particular context of the NHS. Second, unlike quantitative methods such as surveys, case research is well-suited for theory-building (Ketokivi & Choi, 2014). This approach allowed us to develop theory (i.e., a model and set of propositions) regarding how policy-enacting agencies support innovative SMEs to engage with the NHS and its supply chain, and to what effects.

We chose the English NHS as our research setting because of its investment in stimulating the development of innovative technologies, and of an emphasis on the engagement of technology-based SMEs in this process. More generally, public healthcare systems are increasingly reliant on innovation (e.g. new vaccines) to deliver affordable, high-quality care. They are also susceptible to government intervention in the form of policies and regulations that affect supply chain performance (Dobrzykowski, 2019; de Vries et al., 2021), and innovation outcomes more specifically. The NHS is a suitable context in which to study how institutional failures influence procurement and SME-enabled innovation processes because of its complicated institutional set-up in terms of: a) a nexus of rules, regulations, and norms affecting the NHS and its supply chain; and b) a large number of organisations involved in the planning and delivery of public healthcare, whose interrelations are multiple and multifaceted. The online supplement (Appendix S1a) offers a detailed description of the English NHS.

Case Design and Sampling

We employed an embedded multiple-case design (Yin, 2009) to study how the two programmes (InnoMed's HBC and SBRI Healthcare) facilitate SME supplier-enabled innovation in the context of the NHS and its institutional set-up. An embedded case design involves more than one unit of analysis (Scholz & Tietje, 2002). In our study, the two programmes in focus included as embedded cases participating SMEs and their interactions with the agencies executing the programmes. These interactions concerned the development or commercialisation of specific SME products that could be introduced into the NHS. In total, we studied 35 SME products and related SME interactions with the executing agencies. Table 1 presents the SMEs and their innovations in focus. SME firms S7 and S9 participated in both programmes, receiving support for two distinct innovative products of theirs, respectively.

[Insert Table 1 Approximately Here]

We used a combination of criterion (Patton, 2002) and theoretical sampling (Barratt et al., 2011) to select the programmes as applicable to the English NHS, which served as our setting to control for potential country- and sector-level differences in institutions relevant to innovation (Voss et al., 2002). Specifically, our research design controlled for the institutional set-up underpinning procurement and supplier-enabled innovation in the NHS, and for the buying organisation (NHS). For the selection of the programmes, we focused on policies and associated programmes which emphasised support of innovative SMEs. We considered both demand-oriented innovation policies emphasising demand articulation and experimentation with new technologies, and supply-oriented ones focusing on capability development of relevant actors (Edquist et al., 2015). We also considered the innovation process stage(s) that a programme may emphasise, namely innovation development vs. adoption. We expected that some variation in case selection along these criteria would help capture differences regarding SME institutional failures, and the interventions of agencies responsible for policy enactment.

Following this sampling logic, we identified two programmes: AHSNs' SME support programmes and SBRI Healthcare. We subsequently decided to focus on a single AHSN (InnoMed), because of its investments in SME support as compared to other AHSNs, and considering access practicalities. This led to studying in detail InnoMed's HBC programme.

We employed a combination of criterion and snowballing sampling (Patton, 2002) to select the innovative SMEs from a population of 335 firms who had engaged with the two programmes (180 for HBC and 155 for SBRI Healthcare). We consulted InnoMed annual reports and staff and the SBRI Healthcare portal to identify all firms supported by the programmes. To be able to compare the programmes, we decided to focus on SMEs operating in two market segments ('Digital Health' and 'Medtech') which both programmes had defined as part of their target audience and deemed important in line with the NHS's needs. For other defined segments, we observed differences between the programmes (e.g. the 'In-vitro Diagnostics' segment in SBRI Healthcare did not feature in HBC). This decision led to a reduced pool of 204 SMEs. Next, our initial discussions with InnoMed staff revealed that the intensity of interactions with SMEs differed e.g. interactions with SMEs seeking advice unrelated to product development or commercialisation were limited. Subsequently, we asked agencies' staff to identify a subset of SMEs with whom they had rich interactions for product development and /or commercialisation purposes (145 firms in total). At this point, considering also access practicalities, we used snowballing sampling. In line with our focus on SME interactions with agencies, we sought to interview both sides. Our initial interviews with InnoMed and Innovate UK managers thus helped us to target SMEs for detailed study. For example, we asked InnoMed's Commercial Manager 1 to identify all SMEs he was supporting at the time. We then contacted these 17 SMEs and ten of them accepted our interview invite. Overall, we contacted 40 SMEs participating in the HBC programme, out of which 20 firms accepted to participate in the research. Regarding SBRI Healthcare, we contacted 30 SMEs and

13 of these firms accepted to be interviewed. Our interviews with SMEs S7 and S9 for their participation in HBC revealed that these firms had also participated in SBRI Healthcare. We later asked them to provide an account of their engagement with SBRI Healthcare, thus covering a total of 15 SME products supported by this programme. Our final sample included a broad range of SMEs in terms of age and size. Regarding firm age[2], our sample included both 'new'/young SMEs and more established ones. Regarding firm size[3], we interviewed a mix of micro, small and medium-sized firms. Despite our focus on 'Digital' and 'Medtech', during the study we observed that four products did not exactly fit these segments. We thus labelled them as 'Other' (see Table 1). Our diverse sample, especially regarding firm age and size, means that our findings are likely to be applicable to a wide range of innovative SMEs.

Data Collection

We collected data through 57 semi-structured interviews (see Appendix 1). We interviewed staff members from the public agencies (InnoMed and Innovate UK) responsible for policy enactment and execution of the two programmes. We also interviewed founders and senior executives of participating SMEs, who had direct involvement in the product development and commercialisation process. We also spoke to NHS staff (e.g. in hospitals), policy-makers and innovation policy experts. The interviewees spanned multiple expertise areas such as health innovation, procurement and SCM, and (SME) innovation policy. The interviews had an average duration of approximately one hour and almost all of them were audio-recorded and transcribed, resulting in 823 pages of transcription text. Appendix 2 shows the interview questions we pursued, which were designed to elicit information (from multiple actors) on

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[2] We followed Zaremba et al. (2017) in defining 'new' firms as those in existence for a maximum of 6 years. In the HBC programme, our sample included 10 new and 10 established SMEs. Concerning SBRI Healthcare, our sample included 7 new SMEs and 8 established ones.
[3] We adopted the European Commission's (2020) classification of SMEs: micro-businesses (<10 employees), small firms (10-50 employees), and medium-sized firms (51-250 employees). In the HBC programme, our sample included 11 micro-firms, 8 small firms and 1 medium-sized. Regarding SBRI Healthcare, our sample included 9 micro-firms, 5 small businesses and 1 medium-sized. Firms of medium size are less likely to participate in such programmes, which was reflected in our sample.

institutional failures facing SMEs, the interventions of implementing agencies to address such failures, and their effects. Due to the differing features of the programmes in focus, the wording of the questions varied between the two cases. For example, interviews focusing on the HBC programme explored SME perceptions regarding the impact of InnoMed's support. For SBRI Healthcare, interviews explored the aims of the wider SBRI policy, and SME perceptions regarding the implementation of the SBRI Healthcare programme.

To achieve data triangulation (Jick, 1979), we complemented our interview data with documentary evidence and participant observation data. We collected data from 98 documents including InnoMed annual reports and SBRI Healthcare statistics and evaluation reports. We also extracted from these documents basic quantitative data e.g. regarding the number of SME collaborative innovation projects and number and value of SME sales contracts. This data helped to corroborate our findings with respect to SME collaboration with the NHS and SME innovation adoption outcomes, and to probe interviewees further in the few instances where data inconsistencies arose. We also observed two SME training workshops run by InnoMed (on 'NHS governance structure and priorities' and 'NHS procurement'), and a workshop on the role of the UK SBRI attended by SMEs, NHS representatives and innovation policy makers. Our observation data proved instrumental for highlighting the value of SME connectivity to incumbent NHS suppliers. Although this type of connectivity was not widely reported by SME interviewees, our observations coupled with InnoMed and Innovate UK interviews revealed its importance as a key approach to overcoming contracting-related institutional failures.

Data Coding

We followed the approach recommended by Gioia, Corley & Hamilton (2013) to code and analyse our data (see next section for details of the within- and cross-case analysis). We first coded the data for each programme separately. This initially involved open coding (Strauss &

Corbin, 1990) in relation to institutional failures facing SMEs, agencies' interventions and SME support activities, and their effects. We inductively generated first-order codes based on terms used by interviewees, or appearing in documentary evidence. For example, the statement by one of InnoMed's Commercial Managers "*a framework agreement is in place already, so what does the SME do then? It can't get onto [the] framework agreement […]*" was coded as a failure related to SME access to NHS framework contracts. We then compiled the programme-specific findings regarding institutional failures, agencies' institutional interventions and SME support activities, and SME innovation effects into construct-based data displays (Miles & Huberman, 1994). The next section provides examples of such tables. In the course of this process, we iteratively adjusted and re-organised our set of first-order codes into higher-level categories using axial coding (Mello & Flint, 2009). For instance, we initially generated three first-order codes referring to SME institutional failures: 'SME participation in R&D tenders', 'SME access to framework contracts' and 'NHS prioritisation of large, existing suppliers'. These were subsequently collapsed into the second-order code 'limited SME access to NHS contracting'. Such axial coding helped to reduce the data by grouping the 29 first-order codes into a set of second-order codes and aggregate dimensions (Gioia et al., 2013). In another example, during the cross-case analysis we rearranged the observed institutional interventions of agencies into three second-order codes: 'SME-friendly innovation finance and property rights rules, 'SME-friendly contracting rules' and 'SME compliance with innovation adoption rules and norms'. We later grouped these second-order codes into an aggregate dimension which we labelled 'institutional change and mitigation', upon consulting the literature.

In addition to grouping codes, we removed ones that were either: a) programme-specific (e.g. HBC emphasis on changing NHS staff behaviours), or b) relevant to only a few SMEs across the two programmes (e.g. SME lack of manufacturing capabilities). We made exemptions to these two criteria only when the importance of a theme was strongly suggested

by multiple data sources, or by the literature. For example, although SME connectivity to the NHS's suppliers was relevant to thirteen SMEs, our interviews with InnoMed and Innovate UK staff and workshop observations highlighted the importance of this SME connectivity type. The result of this iterative coding process was the data structure shown in Appendix 3.

In developing the second-order codes and aggregate dimensions, we moved from an inductive to an abductive approach (Dubois & Gadde, 2002) as we iterated between our data and the literature. Specifically, our initial analysis suggested that several of the challenges facing SMEs arise from deficiencies in the institutional set-up underpinning the NHS's procurement and supply chain processes. Consequently, at this point, we drew on the systems-of-innovation approach (Edquist, 1997) because, as outlined in the theoretical background section, it emphasises the role of institutions and how policies seek to address institutional failures hindering innovation. We also observed differences in the degree of proactivity of agencies' interventions and iterated with the literature, borrowing from institutional analysis to inform our coding based on different ways organisations respond to institutions (Oliver, 1991). We subsequently distinguished between active approaches geared towards institutional change, and more passive responses focusing on institutional mitigation. This abductive logic also underpinned our development of the other constructs (aggregate dimensions) featuring in Appendix 3. Two researchers were involved in data coding and analysis. The first author led the process and coded all data, while the second author coded portions of the data independently to ensure that a bias-free and rigorous process was followed. During the analysis process, we discussed our evolving coding structure and resolved a small number of differences in our interpretations of the data until we reached full agreement. To ensure validity, we checked our joint interpretations with key participants. More broadly, we took multiple measures to ensure the trustworthiness of our findings (Guba, 1981; Pratt et al., 2020). Appendix 4 presents the evaluation criteria we used and the corresponding actions taken.

ANALYSIS AND FINDINGS

Within-Case Analysis

Within-case analysis helped us to make sense of each programme in terms of its rationale and aims, the executing agencies' interventions, and their effects. Given our embedded case design, for each programme we sought to understand institutional failures facing the participating SMEs, how policy-enacting agencies intervened to address failures and to support these SMEs, and effects in terms of SME collaborative projects with the NHS and SME innovation adoption. Appendix S1b and Appendix S1c in the online supplement show the detailed within-case analysis for the HBC and the SBRI Healthcare programmes respectively.

To examine the relevance of institutional failures that emerged from our interviews to each innovative SME, we looked for statements made by SME interviewees and /or by agency interviewees referring to a specific SME. If a failure was explicitly mentioned for a specific SME, we coded "Y" (yes). If the interviewee(s) noted that the failure was of little relevance to the SME, we coded "L" (limited). We coded "N" (no) if there was no evidence. We then determined for how many SMEs an institutional failure was relevant by summing all "Y" codes. For example, access to framework contracts was a failure perceived by 17 SMEs in our sample of firms participating in HBC (Appendix S1b). A very similar approach was followed for the analysis of agencies' institutional interventions, SME connectivity and SME development support. Regarding the latter, we also examined the technology readiness level (TRL) (Olechowski et al., 2020) of each SME's product to understand whether particular support activities were relevant for that SME. This was because multiple interviewees (e.g. from InnoMed and Innovate UK) suggested that SME development support depends largely on product development maturity. We coded "n/a" (not applicable) when a type of agency support was not deemed relevant considering the SME's product TRL. For each SME, we used interview data to determine whether the product was in the development (TRLs 1-6) or in the

testing /commercialisation phase (TRLs 7-9). Regarding effects on SME-enabled innovation, we combined interviewee statements with secondary data (InnoMed and SBRI Healthcare reports) to determine whether: a) an SME formed collaborative projects with the NHS, and b) the SME's product had been adopted. Our coding of SME innovation adoption (as an effect) included products whose uptake and resulting sales could at least partly be attributed to programme support by SME interviewees (coded "YP"). We coded separately ("ND") SME products for which adoption was a premature outcome as they were still in development.

InnoMed's HBC programme. InnoMed seeks to link the NHS with suppliers of new technologies and products that improve health outcomes. InnoMed's HBC programme specifically aims to support innovative SMEs that could potentially fulfil NHS's unmet needs. The programme helps SMEs with relevant solutions to connect to the NHS, and provides various types of SME support e.g. finance access, SME education, and feedback on SME product development and commercialisation. HBC puts emphasis on the adoption of SME innovations that are in the testing or commercialisation stage. To this end, SMEs are helped to generate clinical evidence through trials at NHS sites that are facilitated and even financed by InnoMed. The agency also intervenes to address institutional failures facing SMEs e.g. by adjusting procurement rules to enable inclusion of SME new products into NHS framework contracts (Appendix S1b). The HBC programme has positive effects on SME-enabled innovation. Collaborative projects with the NHS were formed for eighteen SME products in the sample of 20 products we examined. No projects were formed for two SME products. Regarding innovation adoption, eleven products in the sample had been adopted, while five products were still in development. Four SME products were not adopted.

SBRI Healthcare programme. The aim of the programme is to help develop novel technologies that match NHS's unmet needs, while also stimulating economic growth. It targets technology-based SMEs and start-ups and instigates early-stage R&D and product

development (up to the prototyping stage). Innovate UK and InnoMed share implementation responsibility for the SBRI Healthcare programme. Innovate UK leads the development of programme rules and procedures (e.g. R&D contracting and finance) and advises on SBRI tenders, whose design and execution are the responsibility of InnoMed (and other AHSNs). SBRI Healthcare invites SMEs to bid for innovation contracts, which are awarded in two phases: Phase 1 contracts concern 'proof-of-concept' research and are worth £50-100k. Successful Phase 1 contractors can bid for Phase 2 contracts for prototype development, which are worth up to £1 million. The programme also awards contracts for a small number of product testing and commercialisation projects (informal Phase 3). Throughout this process, SMEs are supported to develop technical knowledge and receive feedback on their product development efforts. SBRI Healthcare-specific rules (e.g. 100% finance of R&D projects) and property rights help SMEs to overcome institutional failures such as access to innovation finance and IP allocation (Appendix S1c). The programme enables SMEs to form collaborative projects with the NHS, but innovation adoption effects are less prominent. In our sample of 15 SBRI-funded products, three were adopted. Six were still in development, and six were not adopted.

Cross-Case Analysis

Cross-case analysis allowed us to identify similarities and differences between the programmes and between participating SMEs. As a first step, we sought to identify patterns with respect to SME institutional failures, agencies' institutional interventions and SME support activities and their effects. We created cross-case tables to understand the relevance of each issue (e.g. institutional failure and agencies' intervention) across programmes and SMEs. Table 2 exemplifies by showing the analysis concerning SME-specific institutional failures. Detailed cross-case analysis tables regarding agencies' institutional interventions, SME connectivity, SME development support and SME innovation effects are shown in the online supplement

(Appendix S1d, S1f, S1h and S1i, respectively). In all these tables we tracked for how many SMEs a particular issue was relevant by summing all "Y" codes (see within-case analysis). Table 3 sums up the key constructs and sub-constructs resulting from the cross-case analysis, and their frequency of occurrence across the programmes and SMEs. Our cross-case analysis also examined relations among the constructs e.g. we sought to discern patterns regarding the link between the TRL of SMEs' products and the type of SME development support provided. Such analysis was aided by pattern-matching tables which are shown in the following sections.

[Insert Table 2 Approximately Here]

[Insert Table 3 Approximately Here]

SME-specific institutional failures. We identified three main forms of SME-specific institutional failures impeding the engagement of innovative SMEs with buying organisations such as the NHS (Table 3). The first concerns SMEs' innovation efforts and SMEs' related views and decisions. SMEs perceive a lack of ability or incentives to conduct collaborative R&D, because of their limited access to innovation finance and uncertainty regarding allocation of intellectual property (IP) rights. Collaborative product development and testing require SME (co-)financing and entail administration costs that SMEs cannot afford. SMEs also feel uncertain regarding their ability to retain any IP resulting from collaborative R&D with the NHS, as they lack legitimacy and power as compared to large, established suppliers.

The second form of institutional failure pertains to NHS tendering and contracting rules, procedures and norms of conduct. Similar to the first failure, this form also makes it costly for SMEs to engage with the NHS. However, this second form concerns NHS's institutional constraints embodied in public procurement processes and practices. Public procurement rules followed by the NHS preclude close engagement with and support of SMEs as potential suppliers, and the NHS lacks a mechanism internally for identifying innovative SMEs and experimenting with their technologies. SMEs stressed limited access to NHS tenders for

innovation because contracts are large, administration costs related to tendering and contract execution are high, and payment terms are extended: these are non-issues for larger firms. NHS procurement rules and practices are also geared towards relationships with large, established suppliers, and discourage sourcing of SME innovations. The dominant emphasis on annual cost saving targets, for example, means that NHS procurement professionals have little incentive to use SMEs, because SMEs' cost-to-serve an order is typically higher. Another SME-specific challenge is the institutionalised use of NHS framework contracts and product catalogues, which result from regulatory pressures to increase efficiency and standardisation in procurement. Compared to established firms, SMEs find it difficult to enter such framework contracts as they have limited or no track record, and because of the narrow windows in which these multi-year framework agreements are re-tendered for. The third form of institutional failure refers to norms and behaviours of NHS staff slowing down adoption of SME innovations. In addition to NHS procurement professionals' aversion to risks and costs related to dealing with SMEs, clinicians embrace a culture of organised scepticism based on their emphasis on patient safety. This means that innovation adoption decisions follow strict bureaucratic rules and procedures that slow down significantly the adoption of SMEs' novel products. Such delays hurt the cash flow of SMEs and their longer-run financial viability. Overall, our findings are consistent with prior research suggesting that procurement practices and norms of conduct and decision-making routines can impede innovation (e.g. Rolfstam, 2013; Bruce et al., 2019).

Agencies' institutional change and mitigation efforts. The two programmes target these SME-specific institutional failures. Our analysis revealed three types of agencies' interventions to change institutions relevant to SME innovation, or to mitigate their effects (Table 3). The policy-enacting agencies create incentives for SME engagement in collaborative R&D with the NHS by shaping new or adjusting existing rules for innovation finance. For example, the SBRI

Healthcare programme provides ring-fenced finance that SMEs can use to collaborate with NHS hospitals in innovation projects that do not require SME co-financing (100% funding of projects). The two programmes also seek to reduce SME uncertainty regarding IP allocation. Innovate UK established a property rights framework that assigns IP developed during SBRI-funded innovation projects to SMEs, rather than to NHS hospitals (the latter retain licensing rights). This arrangement also protects any 'background IP' contributed by SMEs, as stipulated in SBRI Healthcare contract templates we examined. These rules incentivise SMEs to invest effort in collaborative R&D projects. The HBC programme also seeks to reduce IP-related risks as InnoMed advises SMEs to help them comply with relevant regulatory requirements.

InnoMed and Innovate UK also intervene to shape SME-friendly contracting rules and procedures. This is achieved by establishing new rules, adjusting existing ones, or supporting SMEs to bypass cumbersome procedures. Innovate UK has established an R&D contracting process that is tailored to innovative SMEs' needs in that it caters for lot-sizing of contracts i.e. it divides contracts into Phase 1 and Phase 2 lots, thus making it easier for SMEs to bid for them. The SBRI Healthcare programme also entails light-touch tendering and contract management, and creates rules for prompt SME payment linked to pre-determined project milestones. These features were highly appreciated by SMEs e.g.: *"We are a big supporter of the SBRI model. We think that it has been carefully designed to be SME-friendly" (CEO, S29).*

InnoMed adjusts rules and pre-qualification standards for access to NHS framework contracts to make them more accommodating of SMEs participating in the HBC programme. Such interventions are intended to facilitate SME inclusion into NHS framework contracts and product catalogues. In addition, when SME access to NHS framework contracts proves too slow or costly, InnoMed helps SMEs to bypass framework contract rules and standards by guiding them towards more flexible routes (e.g. Dynamic Purchasing Systems). The programmes also educate SMEs about the NHS's governance, decision making procedures and

market entry points, which ensures SMEs' compliance with NHS rules and norms to avoid unnecessary delays to innovation adoption. InnoMed, which is involved also in SBRI implementation, leads SME education activities e.g. workshops on NHS adoption and routes to SMEs' selling into the NHS. These activities seek to mitigate the effects that bureaucratic rules and conservative norms within the NHS have on SME innovation adoption.

In line with prior literature (Oliver, 1991; Wu & Jia, 2018), we find that the agencies' institutional interventions range from being active (e.g. creating new rules) to relatively passive (e.g. helping SMEs to bypass existing rules). Our comparative analysis between the two programmes (Table 4) also suggests that the object of agencies' institutional change and mitigation varies depending on the predominant form of institutional failure. For example, all SMEs in SBRI Healthcare stressed failures regarding innovation finance, IP allocation and access to R&D tendering, and perceived new rules for finance, property rights and R&D contracting as important to tackle the corresponding failures. These failures were perceived as relevant only by a subset of HBC-participant firms.

[Insert Table 4 Approximately Here]

On the other hand, the majority of HBC-participant SMEs highlighted failures regarding access to framework contracts and adoption of new products. Accordingly, they stressed InnoMed's efforts to help SMEs to bypass framework contract rules, to support SMEs to comply with rules and norms pertaining to innovation adoption, and to adjust rules for inclusion in framework contracts e.g.: *"When we originally got onto the NHS Supply Chain framework [contract], we were hit with a barrier to entry that required all parties on the contract demonstrate turnover of at least £1 million in the last 12 months, which is a pretty tall order for a new SME that's only been around six month*s […] they *[InnoMed] managed to have that clause removed from the documents" (CEO, S3).* These interventions were perceived as

relevant by significantly fewer SMEs participating in SBRI Healthcare. Appendix S1e in the online supplement offers multiple example interviewee statements in support of these findings.

SME connectivity to the supply chain. The agencies seek to link innovative SMEs to the NHS, as a buying organisation (Table 3). We observed that improving SME connectivity to the buying organisation featured strongly in both programmes, as also confirmed by the majority of SME interviewees. InnoMed staff felt that brokering connections between SMEs and the NHS was an important part of their contribution. Connections to the NHS facilitate product development and testing, and create SME sales opportunities. Similarly, Innovate UK established a formal structure and process through which innovative SMEs can engage with the NHS as part of their participation in SBRI Healthcare. Connections to the NHS help SMEs to understand clinicians' and patients' unmet needs, and to guide their R&D accordingly.

In addition to connecting SMEs to the buying organisation (the NHS), policy-enacting agencies seek to connect SMEs to established NHS suppliers, as an alternative route to commercialisation and adoption of SME innovations. Although fewer SMEs experienced this type of connectivity than those reporting connectivity to the NHS (Table 3), interviews with both InnoMed and Innovate UK, and our observations of three workshops, suggest that this type of connectivity is deemed important. All InnoMed interviewees stressed that linking SMEs with incumbent NHS suppliers often was a more viable and faster way for SMEs to enter the NHS's supply chain. Innovate UK managers also highlighted benefits for SMEs in terms of potentially integrating their innovations into existing healthcare-related supply chains.

Furthermore, we found that agencies seek to connect SMEs to incumbent NHS suppliers to bypass failures related to procurement of market-ready innovations. Indeed, in one of InnoMed's educational workshops we attended (March 2018), InnoMed staff advised SME participants to consider partnering with incumbent NHS suppliers to start generating sales, given the challenges of securing timely access to NHS framework contracts. InnoMed

interviewees explained that they are more likely to foster links with incumbent suppliers if they felt that an SME's product was proven, but faced entry barriers unrelated to its value e.g.: *"We've got a company that does blood monitoring [...] it's better, cheaper, more efficient [...] but the company isn't on a framework [contract] at the moment so that might not be renegotiated for another 12-18 months, but if they partner with a company that is on the framework then there is the opportunity"* (Commercial Manager 2, InnoMed). These findings are corroborated by our comparative analysis between SMEs linked to NHS's incumbent suppliers and those that were not (Appendix S1g), which shows that failures regarding SME access to NHS contracts for market-ready innovations explain SME connectivity to the NHS's suppliers. All thirteen SMEs connected to NHS suppliers cited limited access to framework contracts and entry barriers related to NHS's prioritisation of established suppliers. These failures were less prevalent for SMEs not connected to incumbent suppliers. Overall, these findings show that policy-enacting agencies help create links between innovative SMEs – as *possible*, *new* suppliers – and the buying organisation and its suppliers. This differs from prior research focusing on the value of connectedness between the buyer and its existing suppliers (Gao et al., 2015), or between the buyer's existing suppliers (Bellamy et al., 2014).

SME supplier development support. The programmes dedicate resources specifically to support participating SMEs to overcome their limitations with respect to access to finance, and knowledge and capabilities. As Table 3 shows, 18 SME products that received support were in the development phase (TRL 1-6), while 17 products in the testing and commercialisation phase (TRL 7-9). We observed that SME development activities differed depending on the TRL of an SME's product. Our analysis in Table 5 shows that the agencies customised their SME development support to fit the TRL of SMEs' products. This was confirmed by interviewees e.g.: *"if they [SMEs] have got a specific product and it is sort of ensuring you get all your evidence together and what testing you've done, that will obviously only be applicable*

to a set of our SMEs" (Commercial Manager 2, InnoMed). Support for SMEs whose efforts focused on TRLs up to prototyping (TRL 1-6) emphasised R&D financing, technical capabilities, and feedback on the technical features and applicability of the new products under development. SMEs falling into this category indeed reported accessing these support types.

[Insert Table 5 Approximately Here]

Regarding the subset of SMEs with products that were in testing and commercialisation stages (TRL 7-9), agencies' support involved direct financing of clinical trials, or alternatively helping to secure funds for clinical evidence generation projects. It also focused on SME development of softer (i.e. non-technical) capabilities related to commercial and sales aspects, and an improvement of SMEs' ability to position and promote their new products, considering also the NHS's unmet needs and operating realities. A key feature of this support mode was to build credibility of both the SME and the new product by showcasing its potential. Overall, we identify TRL as a critical contingency additional to the firm's size and age, which are highlighted as factors influencing supplier-enabled innovation processes (Narasimhan & Narayanan, 2013; Zaremba et al., 2016). In particular, the specificity and timeliness of supplier development (Zaremba et al., 2017) is relative to the TRL of an SME's new product.

Effects on SME-enabled innovation. The agencies' interventions facilitate SME engagement in collaborative innovation projects with the NHS, and SME innovation adoption. In our sample of 35 SME products across the two programmes, collaborative projects were formed for 31 products (Table 3). Only four products did not benefit from such projects. Regarding adoption of SME innovations, fourteen products had been adopted and generated sales that could, at least partly, be attributed to programme support by SME interviewees. Eleven SME products were still in development, and ten products were not adopted. Our analysis in Table 6 suggests that interventions targeting rules for procurement and contracting facilitate SME innovation adoption. Crucially, agencies' interventions to adjust rules and

standards for inclusion in NHS framework contracts were cited by eleven out of the fourteen SMEs with adopted products e.g.: *"I would say, to be fair, [InnoMed Commercial Manager 1] helped us to get the Preston [NHS Trust] order. So, without [him] […] we wouldn't have been able to sell six in Preston" (Managing Director, S5).* Contrastingly, the agencies' support to facilitate SME access to framework contracts were much less prevalent for SMEs whose products were not adopted. SMEs in this subset reported that agencies mainly helped them to access R&D contracts. Agencies' SME education about NHS governance rules and norms also contributed to SME innovation adoption (Table 6). SME education was significantly more prevalent for firms with adopted products than for those whose products were not adopted.

[Insert Table 6 Approximately Here]

Our analysis also shows that all but one SMEs connected to the NHS (as a buying organisation) developed collaborative projects for product development and testing with the NHS (see Appendix S1j in the online supplement). SMEs that were not connected to the NHS did not form such collaborative projects. The majority of SME interviewees stressed that links to the NHS facilitated collaborative innovation activity e.g.: *"So, to all intents and purposes we're working together to see if we can make a meaningful improvement in the efficiency of the NHS and in this particular instance to improve patient flow as partners or collaborators" (CEO, S30).* Regarding the effects of SME supplier development, our analysis shows that agencies' support for product testing and commercialisation facilitated SME innovation adoption. This support mode was significantly more prevalent for SMEs with adopted products than for SMEs whose innovations were not adopted (see Appendix S1k in the online supplement). For example, access to finance for clinical trials facilitated SME innovation adoption: e.g.: *"there was a scale-up fund available […] directly from [InnoMed] and that gave us a platform to take what we'd done […] and really re-develop the entire project so that we could push it across the UK" (CEO, S9).*

DISCUSSION

Our research elucidates various forms of SME-specific institutional failures and shows how policy-enacting agencies seek to tackle these failures to facilitate collaboration between innovative SMEs and buying organisations. Figure 2 synthesises our findings into a research model and set of propositions regarding the interventions of agencies to foster SME supplier-enabled innovation, their contingent application, and effects. Policy-enacting agencies intervene to change or mitigate institutions, to connect SMEs to supply chain actors, and to support SME development. We also show how the form of institutional failures and the TRL of an SME's new product influence the agencies' interventions and SME support activities.

[Insert Figure 2 Approximately Here]

SME-specific Institutional Failures

Prior research suggests that engagement with technologically-adept SMEs can help buying organisations to innovate and create value (Narasimhan & Narayanan, 2013; Zaremba et al., 2016), and that buying organisations need to develop a distinctive set of capabilities more attuned to partnering with innovative small firms (Zaremba et al., 2017). Absence of such capabilities can result in less effective collaboration for innovation (Moschner et al., 2019). Our study contributes to this literature by developing theoretical insights regarding the role played by formal and informal institutions embodied in a buying organisation's procurement and supply chain strategies, processes, and practices. It shows that barriers to engagement between innovative SMEs and buying organisations are not only a matter of buying organisations' lacking capabilities: institutional failure is also a critical factor. Our public-sector setting brings this issue to the surface particularly clearly because the NHS is constrained by public procurement regulations (e.g. competitive tendering). These preclude the distinctive approaches to working with innovative small firms that Zaremba et al. (2017) recommend. In

addition, regulatory pressures to achieve cost efficiency and standardisation result in the use of rigid contracts and prioritisation of relationships with large, established suppliers.

While the broader literature on supplier-enabled innovation processes and outcomes has demonstrated the role of institutions (e.g. Jean et al., 2014; Wang et al., 2016), it has neglected institutional failures that are particularly germane to SMEs. Our study contributes to the literature by developing empirical insights regarding various forms of SME-specific institutional failures. The first form concerns SMEs' innovation efforts. SMEs are less willing or able to engage in collaborative R&D with the buying organisation because of perceived uncertainties regarding finance and IP allocation. Contrastingly, failures associated with NHS contracting rules and practices and NHS staff behaviours which slow down SME innovation adoption relate to constraints facing the buying organisation (NHS). Beyond procurement-related institutional failures already highlighted in the literature (e.g. Bruce et al., 2019), we reveal others pertaining for instance to property rights and innovation finance rules.

Interventions by Policy-enacting Agencies to Foster SME Innovation and their Effects

Addressing SME-specific institutional failures requires intervention and change in the institutional set-up in which buying organisations, innovative SMEs and other actors (e.g. incumbent suppliers) operate, and innovation policies have a role to play in this respect. We show that agencies enacting innovation policies, through specific programmes, shape innovation finance and property rights rules, seek to change contracting rules or to mitigate their effects, and help SMEs to comply with rules and norms influencing innovation adoption processes. Contrary to prior research (Oliver, 1991; Wu & Jia, 2018), we find that interventions do not have a uniform target, but are directed at three distinct objects: institutions related to processes for innovation, procurement and public service delivery, respectively. Our analysis also shows that the object of agencies' institutional change and mitigation work is determined

by the predominant form of failure facing SMEs. For example, to incentivise collaborative innovation between SMEs and the buying organisation, agencies create SME-friendly property rights and innovation finance rules. We thus explicate how SME-specific institutional failures relate to the object of agencies' institutional interventions. In sum, we propose:

P1: The object of policy-enacting agencies' institutional change and mitigation work is contingently linked to the predominant form of institutional failure specific to the engagement of innovative SMEs with buying organisations.

P1a: Agencies are more likely to focus on creating SME-friendly innovation finance and property rights rules when failures regarding SME collaborative R&D with the buying organisation are prevalent.

P1b: Agencies are more likely to shape SME-friendly contracting rules and mitigate rules for procurement of market-ready innovations when failures regarding SME access to contracts are predominant.

P1c: Agencies are more likely to focus on educating SMEs and help them comply with adoption-related rules and norms of the buying organisation when failures regarding SME innovation adoption prevail.

We show that agencies' interventions in institutions related to procurement and norms of public service delivery have a positive influence on SME innovation adoption. Specifically, the agencies' efforts to adjust or shape contracting rules and to educate SMEs facilitate the adoption of SME innovations. We thus build on prior research (Spring et al., 2017) and show how interventions to address SME-specific institutional failures promote SME supplier-enabled innovation. In summary, we propose:

P2: Policy-enacting agencies' interventions to shape rules for procurement of market-ready innovations and to help SMEs comply with the buying organisation's governance rules and norms are positively associated with adoption of SME innovations.

Policy-enacting agencies also facilitate SME connectivity to the buying organisation and to the buying organisation's existing suppliers. The latter can distribute the SME's innovative product, or even manufacture it, once it is market-ready. Connecting SMEs with incumbent suppliers of the buying organisation allows SMEs to avoid certain institutional failures, while still integrating their innovations into the buying organisation's supply chain. We show that SME connectivity to the buying organisation's suppliers is a key way of overcoming institutional failures pertaining to NHS procurement of market-ready innovations, notably limited SME access to framework contracts and entry barriers related to NHS prioritisation of large, established suppliers. To summarise, we propose the following:

P3: Policy-enacting agencies are more likely to connect innovative SMEs to the buying organisation's existing suppliers when institutional failures pertaining to SME access to contracts for market-ready innovations are prevalent.

Our results show that SME connectivity to the buying organisation enables collaborative innovation activity between SMEs and the buyer. Interventions aimed at linking SMEs directly to the buying organisation enable collaborative R&D and provide a mechanism for exploring how an SME's new product could benefit the buyer. In sum, we propose:

P4: SME connectivity to the buying organisation is positively associated with SME engagement in collaborative innovation with the buying organisation.

We extend prior research (e.g. Bellamy et al., 2014; Gao et al., 2015) by showing how policy-enacting agencies help create links between innovative SMEs – as *possible*, *new* suppliers – and the buying organisation and its suppliers, thereby affecting supply chain structure. Although agencies and their programmes seemingly target (SME) firms, they actually generate effects at the supply chain level. Our findings demonstrate the role of public agencies as non-firm actors that instigate restructuring and innovation *of* the supply chain (Spring & Araujo, 2013), in addition to enabling innovation processes *within* the supply chain.

The agencies also support the development of SMEs, as possible suppliers, through access to finance, training, and guidance and feedback on product development and commercialisation. We furthermore show that the TRL of SMEs' novel products determines the mode of SME development support received e.g. up to prototyping, SME development activities focus on R&D financing, and technical knowledge development. In sum, we propose:

P5: SME supplier development support provided by policy-enacting agencies is contingently linked to the TRL of the SME's new product.

P5a: Agencies' SME supplier development activities are more likely to emphasise R&D financing, development of technical capabilities and feedback on technical aspects if SMEs' new products are in development stages (TRLs 1-6).

P5b: Agencies' SME supplier development activities are more likely to emphasise access to finance for evidence generation projects, development of commercialisation-related capabilities and guidance on product promotion if SMEs' new products are in testing and commercialisation stages (TRLs 7-9).

Our results show that SME support for product testing and commercialisation facilitates SME innovation adoption. This support mode was significantly more prevalent for SMEs with adopted products than for SMEs whose products were not adopted. We thus propose:

P6: SME resourcing and guidance for product testing and commercialisation is positively associated with adoption of SME innovations.

These findings extend prior research (Zaremba et al., 2016; 2017) focusing on supplier development efforts of the buying organisation by showing how policy-enacting agencies compensate for the buying organisation's institutional limitations to support the development of innovative SMEs. The agencies' efforts to help develop innovative SMEs, contingently determined by the TRL of SMEs' new products, contribute to the adoption of SME innovations.

Theoretical Implications

Our research focusses on how enacted innovation policies address SME-specific institutional failures and foster SME supplier-enabled innovation in the supply chain. However, it also generates wider theoretical insights regarding the role of policy-enacting public agencies as non-firm actors influencing the supply chain, and the relationship between supply chains and institutions. Supply chains are increasingly seen as networks consisting of nodes and links (Carter, Rogers & Choi, 2015), in which the link between two nodes can affect other nodes, laterally as well as vertically in the supply chain. Wu & Jia's (2018) argument that 'networks carry institutional effects' thus implies that inter-connected organisations embody and perpetuate institutions. In our results, many of the failures impeding collaboration between innovative SMEs and the buying organisation arise from it having adapted to working with established suppliers of mature products. Our study extends the systems-of-innovation perspective (Edquist, 1997) by showing how public agencies enacting innovation policies interact with the institutional set-up, and seek to change institutions or to mitigate their effects. A key way agencies intervene is by helping to add new nodes – the innovative SMEs – and new links, of a different character – between SMEs, the NHS, and /or existing NHS suppliers.

These policy-enacting public agencies, as non-firm actors (Fugate et al., 2019), thus seek to influence supply chain structure. They themselves are additional nodes, even though they are not buyers or suppliers (cf. Pagell & Wu, 2009). When they interact with other nodes (e.g. SMEs and NHS) and learn, they develop and adapt institutional interventions beyond those mandated in their purpose. In this way, there is potentially a reinforcing cycle: institutional change leads to change in the structure of the supply chain-as-network (that includes the policy-enacting agencies), which in turn provides the basis for further institutional change. In so doing, this cycle achieves more than mitigations for each particular SME-specific institutional failure. It engenders capabilities in the SMEs and improvements in the institutional set-up that make

future SME-enabled innovation more likely to be successful, both for the NHS and for other potential customers (e.g. in private-sector industries). In these ways, institutions and supply chains (as networks) are mutually constitutive, and changing one changes the other.

The institutional set-up may change for other reasons, though. For example, the UK's withdrawal from the European Union (Brexit) means it will, most likely, no longer be subject to EU public procurement regulations. This would allow NHS procurement and supply chain professionals to treat innovative SMEs differently to larger suppliers. It would also potentially enable a shift toward a longer-term orientation that goes beyond cost savings and considers innovation as a key enabler for value creation. Were such reform to take place, there would be less need for targeted programmes to support innovative SMEs. That said, institutions are, by definition, enduring, and the norms and practices that have become 'baked in' over many years will not simply disappear with the passing of a piece of legislation. As such, programmes fostering SME innovation will still be needed in the medium-term.

Transferability of Findings, Limitations and Future Research

Although originally grounded in the empirical context of the English NHS, our findings are transferable to other public sector settings where SME supplier-enabled innovation is important such as defence and digital public services. For example, the UK Ministry of Defence (MoD) is in search of disruptive technological solutions to address contemporary challenges (e.g. cyber warfare) in an operating context of human resource shortages and a widening gap in the funding of defence equipment upgrades and replacements. Similar to the NHS, the MoD is a powerful buyer (quasi-monopsony) seeking to integrate innovations developed by technology-based SMEs into its supply chain. In this setting too, institutional failures (e.g. stringent procurement rules) impede innovation, and policies are enacted to support SMEs e.g. through their engagement in collaborative R&D with the MoD and its first-tier defence suppliers.

Beyond public sector settings, our findings are potentially transferable to private-sector industries wherein public agencies also enact policies to stimulate SME innovation. For instance, in aerospace and automotive sectors featuring multi-tiered supply chains, original equipment manufacturer (OEM) customers with a limited ability to engage directly with small suppliers farther upstream, or indeed with technologically-adept SMEs that are alien to the supply chain, may be missing opportunities to tap into SMEs' innovation potential and unique capabilities. Policies and related programmes can foster direct links between innovative SMEs and OEMs, or connect SMEs to existing suppliers of the focal OEM. More generally, our findings regarding the effects of institutions on supply chains are transferable to private-sector industries wherein regulations or norms restrict innovation. Policies are thus required to make firms act differently in terms of their innovation efforts (Spring et al., 2017).

The study focussed on the English NHS. Further research in other public-sector settings is needed to advance theory on how policies and related programmes promote SME supplier-enabled innovation. In addition, we have not explicitly considered end-users (e.g. clinicians and patient groups) and incumbent suppliers as key stakeholders in the innovation process. Future research should examine how these actors influence the enactment of SME innovation policies. Despite these limitations, our study provides theoretical and empirical insights regarding the interventions of policy-enacting agencies to address SME-specific institutional failures. Future research could build on these insights to analyse the effects of innovation policy on private-sector supply chains. More broadly, and in line with the direction set by the second EDI (Fugate et al., 2019), SCM scholars are presented with exciting opportunities to study not only how industrial and innovation policies affect supply chains, but also how SCM research and practice can in turn inform policy design, implementation and evaluation in these areas.

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APPENDIX 1
The List of Interviewees per Programme Studied

Case study	Organisations	Interviewee(s) role	# interviews
InnoMed's HBC programme	SME S1	CEO	1
	SME S2	Chairman & Head of Innovation	1
	SME S3	Managing Director	1
	SME S4	Operations Manager	1
	SME S5	Managing Director	1
	SME S6	Sales Manager	1
	SME S7	Project Manager	1
	SME S8	Chief Technology Officer	1
	SME S9	Chief Executive	1
	SME S10	Healthcare Director	1
	SME S11	Managing Director	1
	SME S12	Managing Director	1
	SME S13	Managing Director	1
	SME S14	Head of Sales & Business Development	1
	SME S15	Managing Director	1
	SME S16	Managing Director	1
	SME S17	CEO	1
	SME S18	Co-founder & Director	1
	SME S19	Managing Director	1
	SME S20	CEO	1
	InnoMed	Chief Operating Officer & Associate Commercial Director	1
	InnoMed	Commercial Manager 1, HBC (Sub-region 1)	2
	InnoMed	Commercial Manager 2, HBC (Sub-region 2)	1
	InnoMed	Commercial Manager 3, HBC (Sub-region 3)	1
	InnoMed & UniversityA	Commercial Manager 1, HBC & Business Engagement Manager, UniversityA	1
	UniversityA	Business Engagement Manager, UniversityA	1
	UniversityA	Health innovation expert & Project Manager	1
	NHS Trust 1	Procurement Director	1
	NHS Trust 2	Head of Procurement & Commercial Finance	1
	NHS Trust 3	Head of Procurement	1
	NHS Trust 4	Deputy Finance Director	1
	(Regional) Procurement Development Agency	Assistant Director	1
SBRI Healthcare programme	SME S21	Co-founder and CEO	1
	SME S22	Founder and CEO	1
	SME S23	CEO	1
	SME S24	CEO	1
	SME S25	Founder and CEO	1
	SME S26	CEO	1
	SME S27	Senior Innovation Manager	1
	SME S28	Managing Director	1
	SME S29	CEO	1
	SME S30	CEO	1
	SME S31	Co-founder	1
	SME S32	CEO	1
	SME S33	CEO	1
	SME S7	Project Manager	1
	SME S9	Project Manager & Chief Executive	1
	Innovate UK	SBRI Account Manager 1	2
	Innovate UK	SBRI Account Manager 2	1
	Innovate UK	Regional Manager	1
	InnoMed	Operations Director & Associate Commercial Director	1
	Department of BEIS	Assistant Director, Innovation Procurement Policy	1
	Cambridge University	Innovation policy expert & designer of the UK SBRI	1
	Warwick University	Innovation policy expert (Ex-Director at Innovate UK)	1
	Healthcare research agency	Head of Innovation & SBRI Programme Manager	1
		Total number of interviews	**57**

Interview questions for InnoMed's HBC programme

Background questions [all interviewees]
- What is your role within the organisation? What does your job entail?
- Overview of the organisation and its mission and goals?

InnoMed-focused questions
- What is the role and main objectives of InnoMed as an organisation /AHSN? *[context information]*
- Can you provide an overview of InnoMed's SME support programmes? *[policy interventions]*
- Why and how do you support innovative SMEs? *[policy interventions]*
- What are the goals of the Healthcare Business Connect (HBC) programme, and how does it work? *[policy interventions]*
- What types of support services are available to SMEs you engage with? *[policy interventions]*
- What factors influence the support services provided to SMEs? *[policy interventions]*
- What has been the impact of InnoMed's support (both HBC and more broadly)? *[effects on SME-enabled innovation]*
- What do you as key barriers to adoption and diffusion of innovations into the NHS? *[SME institutional failures]*
- What is the role of institutional constraints e.g. NHS procurement rules? *[SME institutional failures]*
- In which ways are you seeking to support adoption of SME innovations? *[policy interventions]*
- To what extent does InnoMed /other AHSNs can drive change in the NHS? *[policy interventions; effects on SME-enabled innovation]*

SMEs-focused questions
- Can you provide a brief description of the new product /technology? *[context information]*
- What do you see as key challenges of working with the NHS (if any)? *[SME institutional failures]*
- Why did you decide to engage with InnoMed? How long for, and how did it all start? *[context information]*
- How does InnoMed support your company? Types of support provided? *[policy interventions]*
- How satisfied are you with InnoMed and the quality of its support services? Any related issues? *[policy interventions; effects on SME-enabled innovation]*
- What is the impact of InnoMed's support on your business (sales; funding; capabilities; growth)? *[effects on SME-enabled innovation]*
- What do you see as the role and impact of AHSNs more broadly? *[policy interventions; effects on SME-enabled innovation]*
- What are the key challenges that your company is currently facing? Next steps? *[SME institutional failures; context information]*

NHS procurement professionals-focused questions
- Can you provide an overview of the NHS procurement and supply chain landscape? Key actors? *[context]*
- What are the main procurement routes for a NHS Trust? *[context information]*
- What are the main goals and incentives of NHS procurement professionals? *[institutional set-up]*
- To what extent are procurement processes and practices conducive to innovation? *[institutional set-up; SME institutional failures]*
- How do rules and regulations influence procurement practices? *[institutional set-up; SME institutional failures]*
- How do you go about procuring an innovative product /service by a small firm? *[SME institutional failures]*
- What are the key challenges of dealing with innovative SMEs? *[SME institutional failures]*
- What are the main challenges facing NHS procurement professionals currently? *[SME institutional failures]*
- How do you see the role of InnoMed /AHSNs in supporting innovation adoption? *[policy interventions]*
- To what extent do you interact with InnoMed? What for? *[policy interventions]*

Interview questions for the SBRI Healthcare programme

Background questions [all interviewees]
- What is your role within the organisation? What does your job entail?
- Brief overview of the organisation and its goals?

Innovate UK-focused questions
- What are the aims of the UK SBRI programme? *[context information; policy interventions]*
- What are the main design features of the SBRI? *[policy interventions]*
- How is the R&D contracting process designed, and why? *[policy interventions]*
- What is the approach to R&D contract management? *[policy interventions]*
- What is the rationale for the distinction between Phase 1 and 2 contracts? *[policy interventions]*
- To what extent is the SBRI process designed to be SME-friendly, and why? *[SME institutional failures; policy interventions]*
- How is the SBRI scheme implemented in practice? *[policy interventions; SME institutional failures]*
- Can you please provide an overview of the SBRI Healthcare programme? *[policy interventions]*
- What is the impact of the SBRI so far? How effective has it been? *[effects on SME-enabled innovation]*

SMEs-focused questions
- Can you provide a brief description of your product /technology? *[context information]*
- Why did you decide to engage with the SBRI? What do you expect to gain? *[context information]*
- How many SBRI competitions has your company participated in? *[context information]*
- How many R&D contracts have you been awarded? Amount of funding received? *[context information]*
- How did you experience the SBRI contracting process? Any related challenges? [policy interventions; SME institutional failures]
- How do you perceive as the key benefits of the SBRI? *[policy interventions]*
- How satisfied are you with the quality of the SBRI's support? *[policy interventions; effects on SME-enabled innovation]*
- What is the impact of the SBRI's support on your company (intellectual property generated; NHS sales; additional R&D funds; growth; capability development)? *[effects on SME-enabled innovation]*
- How effective has the SBRI been more broadly? Any related challenges? *[effects on SME-enabled innovation; SME institutional failures]*
- To what extent can SMEs engage with the NHS? Any challenges? [*SME institutional failures*]
- What is your view on commercialisation and adoption aspects? [*SME institutional failures*]
- If relevant, what are your experiences in dealing with NHS procurement? [*SME institutional failures*]

Policy experts and SBRI user organisations-focused questions
- What are the aims of the UK SBRI programme? *[context information; policy interventions]*
- How is the SBRI designed, and why? *[policy interventions]*
- How is the SBRI implemented in practice, especially in the NHS? *[policy interventions]*
- How effective is the SBRI programme, and what are the key related challenges? *[effects on SME-enabled innovation]*
- What can be done to improve its effectiveness? *[policy interventions]*

APPENDIX 3
The Data Coding Structure

First-order concepts	Second-order themes	Aggregate dimensions
1. Limited SME access to innovation finance 2. SME uncertainty regarding allocation of intellectual property (IP) rights	Limited SME ability /incentives for collaborative R&D	SME-specific institutional failures
3. SME participation in R&D tendering is challenging 4. Limited SME access to NHS framework contracts /catalogues 5. NHS procurement professionals prioritise large, existing suppliers	Limited SME access to NHS contracting	
6. Slow-moving adoption decisions within the NHS (hurts SMEs' financial viability) 7. Organised skepticism and risk aversion by NHS staff	Barriers to adoption of SME innovations	
8. Implementing agencies shape or adjust innovation finance rules 9. Agencies create IPR rules and /or advise SMEs regarding handling of IP issues	SME-friendly innovation finance and property rights rules	Institutional change and mitigation
10. Implementing agencies shape or adjust NHS contracting rules and procedures 11. InnoMed helps to bypass rules regarding inclusion to framework contracts	SME-friendly contracting rules	
12. InnoMed educates SMEs about NHS structure, governance rules, market entry points 13. SME compliance with regulatory requirements and processes to mitigate adoption hurdles	SME compliance with innovation adoption rules and norms	
14. Agencies connect innovative SMEs to the NHS (e.g. hospitals) to explore R&D opportunities 15. Agencies connect SMEs to NHS senior managers to create sales opportunities	SME connectivity to the buying organisation	SME connectivity to the supply chain
16. InnoMed connects SME to existing suppliers to overcome limited SME access to NHS contracts 17. SBRI Healthcare considers commercialisation routes via existing NHS suppliers	SME connectivity to the buying organisation's suppliers	
18. Agencies finance R&D projects and /or support SMEs to access R&D finance 19. Agencies help SMEs develop technical knowledge /capabilities 20. Agencies provide feedback and guidance on SMEs' product development efforts	SME resourcing and guidance for prototyping	SME supplier development support
21. Agencies finance clinical trials /demo projects for evidence generation purposes 22. Agencies help SMEs develop commercialisation-related knowledge and capabilities	SME resourcing and guidance for testing/commercialisation	
23. Agencies' SME development support varies depending on SME product maturity level 24. SME products in early stage R&D or prototyping: 1B SME products 25. SME products in testing and commercialisation phase: 17 SME products	SME product development: TRL 1-6	TRL of SME's new product
	SME product testing and commercialisation: TRL 7-9	
26. HBC effects on SME engagement in collaborative projects with NHS : 18 SMEs collaborated with NHS in evidence generation or development projects for their products 27. SBRI Healthcare effects on SME engagement with NHS: Thirteen SMEs engaged in collaborative R&D or clinical trials projects with the NHS	SME collaborative innovation projects with buying organisation	SME-enabled innovation in the supply chain
28. HBC effects on SME innovation adoption: Eleven SME products were adopted and generated sales; six SME products had not been adopted; three SME products in development 29. SBRI Healthcare effects on SME innovation adoption: Three SME products were adopted and generated sales; six SME products had not been adopted; six SME products in development	SME innovation adoption within the supply chain	

APPENDIX 4
Measures to Ensure Research Trustworthiness

Trustworthiness criteria	Definition	Methodological measures taken
Credibility	Refers to giving voice to multiple perspectives found in one's data to establish truth value of findings. Credibility relates to approval of the data and findings by research participants and peers (Guba, 1981; Pratt et al, 2020).	Checks on validity of key findings and feedback provision by research participants were enabled through: • Sharing summary research reports with research participants (one per case). • Conducting workshops (one per case) with key contacts to present findings and discuss policy implications. Data triangulation (Jick, 1979) by collecting and analysing data through semi-structured interviews, analysis of documents and participant observation session. The aim was to understand multiple perspectives, complement data, and to corroborate emerging findings. Basic quantitative data (e.g. number of products adopted) extracted from documents helped to triangulate interviewee accounts regarding effects on SME-enabled innovation. Presentation of analysis and tentative conclusions to peer scholars and related feedback helped to keep in check validity of findings
Dependability	Refers to the consistency and traceability of data collection and analysis procedures. Dependability relates to the transparency of the research process (Lincoln & Guba, 1985).	Audit trail (Guba, 1981) of the research process established through: • Explication of the case selection criteria, see Method section • Creation of interviewee database, see Appendix 1 • Development and use of an interview guide for each case, see Appendix 2. • Documentation of the data coding and analysis process: see Appendix 3 for the data coding structure and the "Data coding" and "Analysis and findings" sections for details of coding and analysis.
Transferability	Refers to the applicability of the findings to other research settings or contexts (Guba, 1981).	Transferability was enabled through (Lincoln & Guba,1985): • Purposive /theoretical case selection, see Method section. Emphasis on transferring findings to settings exhibiting similar (theoretical) characteristics. • 'Thick' description of the (NHS) research setting guided discussion of transferability of findings to other public (and private) sector settings, see Discussion section. • Collection of rich data and detailed case descriptions allow readers to judge transferability of findings to other contexts.
Confirmability	Refers to the extent to which research findings and conclusions are bias-free, and can be logically derived from the data (Pratt et al., 2020).	Triangulation of interview data (Guba, 1981): selecting interviewees from multiple organisations (e.g. agencies enacting policies, SMEs, NHS) and with different functional expertise (e.g. R&D, procurement, innovation policy experts) allowed comparing /contrasting multiple views and complementing data. Confirmability audit (Lincoln & Guba, 1985) enabled by the development and maintenance of a case study database comprising all interview transcripts, collected documents, memos, observation notes and the (evolving) codes

TABLE 1
The Innovative SMEs Who Participated in the Two Programmes

SME	Programme(s)	Size (#employees)	Age (#years)	Market segment	Innovative solution(s) in focus
S1	HBC	16	3	MedTech	Medical 3D-printing applications
S2	HBC	15	9	MedTech	Snoring relief device
S3	HBC	10	8	MedTech	Latex-free surgical gloves
S4	HBC	9	7	MedTech	Nasogastric feeding tube confirmation device
S5	HBC	2	1	MedTech	Evacuation foldable stretcher
S6	HBC	30	14	MedTech	Portable ultrasound device for primary care
S7	HBC and SBRI Healthcare	12	16	MedTech	1. Portable vital signs monitoring device (HBC), 2. Device to prevent bed falls for elderly people (SBRI Healthcare)
S8	HBC	5	3	MedTech	Thermal imaging-based technology for fall detection
S9	HBC and SBRI Healthcare	10	8	Digital Health	1. App for real-time info for children ailments (HBC), 2. App supporting dementia patients with hospital visits (SBRI Healthcare)
S10	HBC	27	19	Digital Health	Hospital data management system
S11	HBC	11	15	Digital Health	Preventive health IT solution
S12	HBC	1	1	Digital Health	GP engagement and self-case platform
S13	HBC	9	1	Digital Health	Clinical audit solutions for hospitals
S14	HBC	7	3	Digital Health	Interactive physiotherapy platform
S15	HBC	2	4	Digital Health	Remote assessment and monitoring of swallowing problems
S16	HBC	3	2	Digital Health	Kidney disease assessment application
S17	HBC	6	2	Digital Health	Health transport and distribution planning application
S18	HBC	4	3	Other	Children's mental disorders and anxiety treatment method
S19	HBC	6	10	Other	Infection control solutions for hospital wards and ambulances
S20	HBC	136	15	Other	Clinical R&D services relevant to NHS
S21	SBRI Healthcare	8	6	Medtech	Screening solution (ECG device) for cardiac arrhythmias
S22	SBRI Healthcare	5	1	Digital Health	E-platform connecting pharmacies with patients and clinicians
S23	SBRI Healthcare	3	7	Medtech	Transdermal Fluid Removal (TFR) technology
S24	SBRI Healthcare	57	8	Digital Health	E-medical records and data sharing solution
S25	SBRI Healthcare	15	8	Medtech	Sleep mask for treating diabetic retinopathy
S26	SBRI Healthcare	2	4	Medtech	Enuresis solution based on radio-frequency technology
S27	SBRI Healthcare	6	4	Digital Health	Bed capacity management solution for hospitals
S28	SBRI Healthcare	9	19	Medtech	Technology to diagnose faecal incontinence in patients
S29	SBRI Healthcare	11	5	Medtech	Application for self-management of persistent pain (chronic pain)
S30	SBRI Healthcare	7	1	Medtech	Accurate respiratory monitoring technology
S31	SBRI Healthcare	3	8	Digital Health	Technology to assist communication of disabled children
S32	SBRI Healthcare	15	5	Digital Health	Technology to assist patients with brain injury in cooking
S33	SBRI Healthcare	2	11	Other	Hand-hygiene solution to combat hospital infections

TABLE 2
Analysis of SME-specific Institutional Failures Across the Programmes and Participating SMEs

Constructs	InnoMed's HBC programme																				SBRI Healthcare programme														
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	S28	S29	S30	S31	S32	S33	S7	S9
SME ability /incentives for collaborative R&D																																			
Access to innovation finance **[Count=29]**	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	L	Y	Y	Y	N	Y	L	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
IP allocation uncertainty **[Count=24]**	L	N	N	Y	Y	N	Y	Y	Y	N	N	Y	N	N	Y	Y	N	Y	N	L	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
SME access to NHS contracting																																			
Participation in R&D tendering **[Count=26]**	Y	N	N	Y	N	L	Y	Y	L	Y	Y	Y	N	N	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Access to framework contracts **[Count=30]**	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	L	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Prioritisation of established suppliers **[Count=21]**	Y	L	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	L	Y	L	N	Y	N	Y	N	N	Y	L	N	N	Y	Y	N	Y	Y	Y	L	Y
SME innovation adoption barriers																																			
NHS slow-moving adoption decisions **[Count=32]**	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	L	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y

| NHS organised scepticism and risk aversion **[Count=31]** | | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y | Y | L | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | N | Y |

Y= yes, SME experienced /perceived issue as failure; N=no, SME did not experience /perceive issue as failure; L= SME experienced /perceived failure to a limited extent

TABLE 3
TABLE 3
The Constructs and Sub-Constructs Resulting from the Cross-Case Analysis

Constructs (aggregate dimensions) and their definitions	Connections to prior literature /theory	Related sub-constructs (second- and first-order codes)	SME product-related interactions (n=35)
SME-specific institutional failures Deficiencies in the institutional set-up (e.g. rules and norms of conduct) that hinder engagement between innovative SMEs and buying organisations, and SME innovation.	Systems-of-innovation perspective: institutions as barriers to innovation potentially (Edquist & Johnson, 1997)	*Limited SME ability /incentives for collaborative R&D* - Access to innovation finance - IP allocation uncertainty *Limited SME access to NHS contracting* - Participation in R&D tendering - Access to framework contracts - Prioritisation of established suppliers *SME innovation adoption barriers* - NHS slow moving adoption decisions - NHS organised scepticism and risk aversion	 29 24 26 30 21 32 31
Institutional change and mitigation Institutional change refers to the adjustment of existing institutions or to the creation of new institutions. Institutional mitigation concerns efforts to attenuate institutional effects. Institutional change and mitigation seek to address SME-specific institutional failures.	Systems-of-innovation: enacted innovation policies seek to shape an institutional set-up conducive to innovation (Edquist, 1997). Institutional theory: institutional responses vary in terms of their level of proactivity – can be more active or more passive (North, 1990; Oliver 1991)	*SME-friendly innovation finance and property rights rules* - Shaping /adjusting innovation finance rules - Creating IP rules and advising SMEs on IP handling *SME-friendly contracting* - Shaping or adjusting procurement rules - Helping SMEs to bypass rules regarding inclusion in framework contracts *SME compliance with innovation adoption rules and norms* - SME education	 27 22 26 21 24
SME connectivity to the supply chain Efforts by implementing public agencies to connect innovative SMEs to the buying organisation, and /or to the buying organisation's existing suppliers.	Systems-of-innovation perspective: enacted innovation policies seek to connect relevant actors (Dodgson et al., 2011)	*SME connectivity to the buying organisation* *SME connectivity to the buying organisation's suppliers*	32 13
TRL of SME's new product Measurement framework to assess technology maturity, ranging from the early stage of idea generation through to product development, testing, and commercialisation.	Innovation literature: TRL is used in many variations to evaluate technology maturity (Nakamura at al. 2013). TRL scales converge to the following standards: TRLs 1-6 refer to 'proof-of-concept' research, product validation and prototyping, and TRLs 7-9 to demonstration and commercialisation (Olechowski et al., 2020).	*TRL 1-6: product development* *TRL 7-9: product testing & commercialisation*	18 17
SME supplier development support Direct and indirect support provided by implementing public agencies to innovative SMEs (as potential suppliers of innovation), depending on the needs of the SMEs.	Systems-of-innovation: policies shape institutions that channel resources to innovation (Edquist & Johnson, 1997). SCM literature: Direct (e.g. financing and training) vs. indirect (e.g. guidance) supplier development (Wagner, 2010)	*SME resourcing and guidance for prototyping* - Access to R&D finance - Technical capabilities development - Feedback and guidance on product development *SME resourcing and guidance for testing / commercialisation* - Finance for clinical trials /demonstration projects - Commercialisation capabilities development	 16 15 16 14 15
SME-enabled innovation in the supply chain Effects of programme support to participating SMEs in terms of SME collaboration with the NHS in innovation projects, and adoption of SME innovations	SCM literature: SMEs can be a source of novel products /services and critical R&D inputs and innovative ideas for the buying organisation (Narasimhan & Narayanan, 2013; Zaremba et al., 2016)	*SME collaborative innovation projects* *SME innovation adoption*	31 14

TABLE 4
Comparative Analysis of Agencies' Institutional Change and Mitigation Efforts between the Two Programmes

	HBC programme SME count (n=20)	SBRI Healthcare programme SME count (n=15)
SME-friendly innovation finance and property rights rules		
Shaping /adjusting innovation finance rules **[Count=27]**	12Y (+3L)	15Y
IP rules setting and SME advice regarding IP handling **[Count=22]**	7Y (+1L)	15Y
SME-friendly contracting rules		
Shaping or adjusting procurement rules **[Count=26]**	11Y (+2L)	15Y
Helping SMEs to bypass framework contracts rules **[Count=21]**	18Y	3Y (+3L)
SME compliance with innovation adoption rules and norms		
SME education regarding NHS rules and norms of conduct **[Count=24]**	17Y (+2L)	7Y (+1L)

TABLE 5

Analysis of the Relationship between Agencies' SME Supplier Development Activities and the TRL of SME's New Product

	TRL 1-6: product development Number of SME products supported through… (n=18)	TRL 7-9: testing & commercialisation Number of SME products supported through… (n=17)
SME resourcing and guidance for product prototyping		
Access to finance for R&D projects **[Count=16]**	14Y	2Y
Technical capabilities development **[Count=15]**	15Y	0Y (1L)
Feedback /guidance on product development **[Count=16]**	16Y	0Y (2L)
SME resourcing and guidance for testing / commercialisation		
Access to finance for trials /demo projects **[Count=14]**	0Y	14Y
Commercialisation guidance and related knowledge development **[Count=15]**	0Y (1L)	15Y (+1L)

TABLE 6
Effects of Agencies' Institutional Change and Mitigation Efforts on SME Innovation Adoption

	Number of SMEs whose innovations have been adopted (n=14)	Number of SMEs whose innovations haven't been adopted (n=10)
SME-friendly innovation finance and property rights rules		
Shaping /adjusting innovation finance rules [Count=27]	9Y	8Y
IP rules setting and SME advice regarding IP handling [Count=22]	5Y (+1L)	7Y
SME-friendly contracting rules		
Shaping or adjusting procurement rules [Count=26]	13Y* (+1L)	7Y**
Helping SMEs to bypass framework contract rules [Count=21]	12Y***	3Y**** (+2L)
SME compliance with innovation adoption rules and norms		
SME education regarding compliance with NHS rules and norms [Count=24]	13Y	4Y (+2L)

* Eleven out of these thirteen SMEs reported that they were supported to access framework contracts, while two stated that were helped to access R&D tenders

** Six out of these seven SMEs stated that they were supported in accessing R&D contracting, and only one reported help to access a framework contract

*** Eleven out of these twelve SMEs stated that they were supported to access framework contracts, while one reported facilitation of access to R&D contracting

**** All three SMEs reported that they received support for accessing framework contracts

FIGURE 1
The Research Setting and the Programmes in Focus that Enact SME Innovation Policies
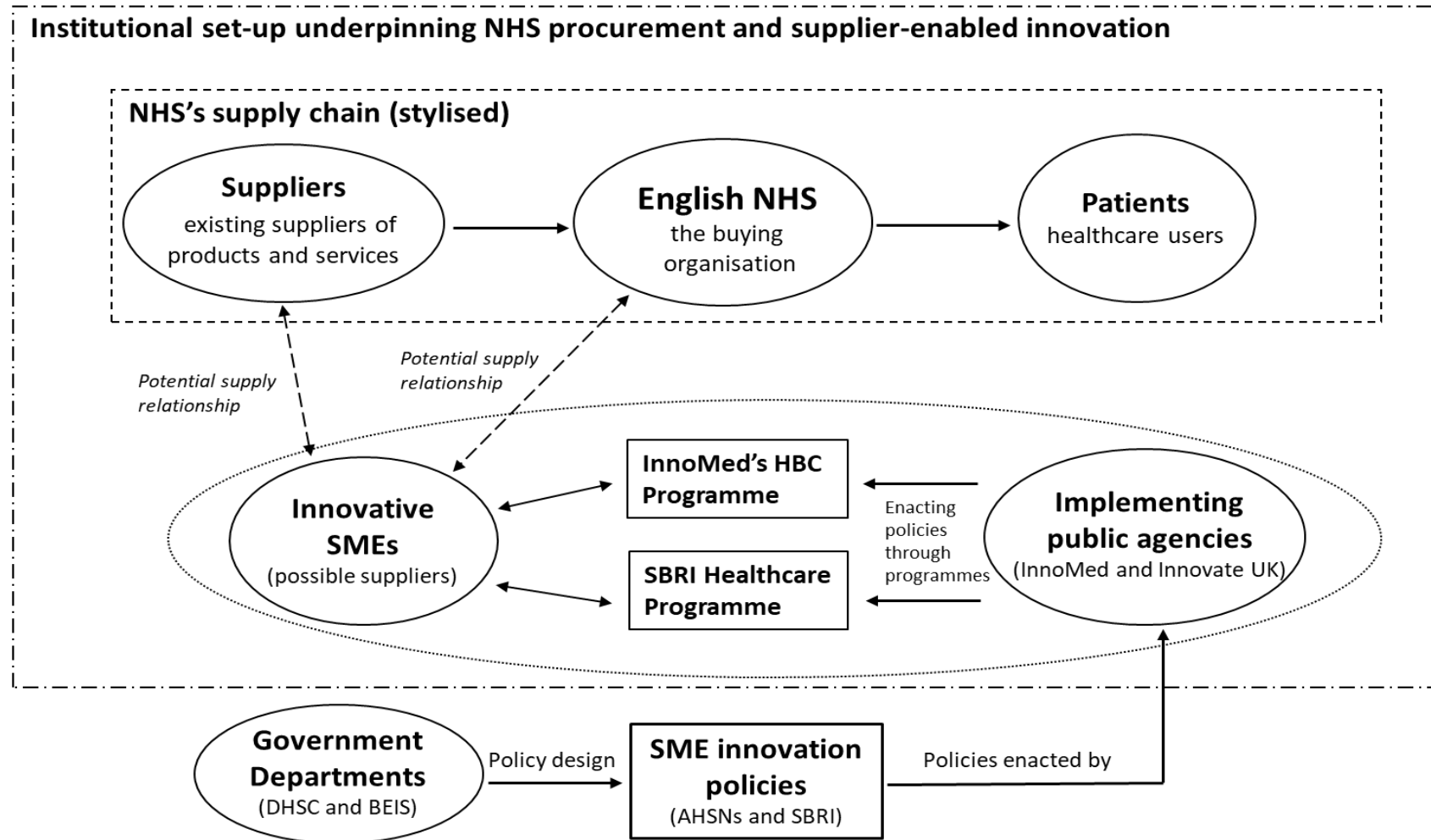
FIGURE 2

Research Model of Policy-Enacting Agencies' Interventions to Foster SME Supplier-enabled Innovation in the Supply Chain, their Contingent Application, and Effects