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SME performance in core and peripheral UK regions: Exploring the role of innovation and firm networks during times of financial distress

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SME performance in core and peripheral UK regions: Exploring the role of innovation and firm networks during times of financial distress*

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ABSTRACT

Purpose: The global financial crisis triggered by the Covid-19 pandemic sparked the closure of many small and medium sized enterprises (SMEs) across the globe. Given that innovation and networking can be used as strategies to improve firm performance, this study examines their (i) direct effects, and (ii) interaction effects with the Covid-19 recession, on the performance of SMEs in the UK.

Design/methodology/approach: We carried out panel data analysis on firm-level data from the '*UK Longitudinal Small Business Survey 2015-2021'*, collected by the Department for Business, Energy, and Industrial Strategy (BEIS). The survey provides rich information on firm characteristics up to and including the Covid-19 pandemic period.

Findings: Our study generates several interesting results. First, we find that both networking and financial obstacles are associated with firm performance. However, the former is positively associated with financial turnover whereas the latter is found to be negatively associated with it. These results are robust across different estimations. No significant interaction effects are found between these variables and the Covid-19 recession dummy. Second, we find the interaction effect between innovation and the Covid-19 recession dummy to be positive and statistically significant. This may suggest that innovation can be an important resilience strategy for SME performance during periods of economic downturn. Third, we find significant regional differences between the SMEs that operate in peripheral regions and those operating in core regions (i.e., London and South East). Fourth, we find significant associations between a number of other variables (e.g., exporting, firm size, firm age, type of firm) and firm performance.

Originality/value: The paper contributes to the theoretical and empirical literature on pandemic-driven/financial crisis and the resilience of SMEs. We generate our findings by empirically testing the direct link between innovation, networking, financial obstacles, and several other variables, and SME performance, and by examining the potential interaction effects of the key explanatory variables with a Covid-19 recession dummy.

Keywords: Covid-19 financial crisis, SME performance, innovation, networking, regions.

Contents

1. INTRODUCTION

The Covid-19 pandemic seriously affected the small business community (see Institute for Government, 2020; Simply Business, 2020). This is because the lockdown policies that were implemented in many countries triggered a worldwide financial liquidity crisis, which in turn sharply increased firm closure (Farsalinos et al., 2021; Kabir and Abubakar, 2023). In many countries, a large number of small and medium-sized enterprises (SMEs) experienced weakened demand (Bartik et al., 2020), and an untold number of SMEs failed (Cowling et al., 2020).[1] Consequently, there has been a lot of interest in researching the effects of the Covid-19 recession[2] on the survival and performance of SMEs. For example, scholars have examined the impact of Covid-19 on the survival of ethnic minority businesses (Kabir and Abubakar, 2022), village-owned enterprises (Yaya et al., 2022), etc. However, notwithstanding the substantial amount of research on the effects of Covid-19 financial crisis on enterprises, at least three main gaps remain in the literature.

Firstly, there is very limited research into the interaction effects of innovation and the Covid-19 recession on SME performance. In this context, we take the Schumpeterian view that periods of financial crisis and economic decline tend to generate new opportunities for small businesses and entrepreneurs (Schumpeter, 1934). In the Schumpeterian context, financial crisis are periods of 'creative destruction'; times when outdated products and industries go into decline and new products and industries develop and grow (Schumpeter, 1934). Hence, innovative firms utilise innovation for generating revenue in such periods of financial crisis and constraints, thereby becoming more resilient and improving their survival chances and performance (e.g., Mangani and Tarrini, 2017; Yaya et al., 2022). Yet, to date we have little understanding of how innovation interacts with Covid-19 financial constraints to affect SME performance.

[1] For example, a study by Bartik in the United States (US), suggests that around 43% of the sampled SMEs had to close their businesses temporarily and up to 40% had to reduce their employment size (Bartik et al., 2020). In Indonesia, thousands of small enterprises closed down because of the financial crisis caused by the Covid-19 recession (Yaya et al., 2022). In Indonesia, where 51,000 village-owned enterprises had been operating in 2019 (Rahmawati, 2020), only 10,026 were operating as of September 2020, most having closed down because of the Covid-19 financial crisis (see Katadesa, 2020; Yaya et al., 2022).

[2] At this point, it should be mentioned that the Covid-19 period overlaps with the formal departure of the United Kingdom from the European Union (EU). Separating out the potential two effects on firm performance, although making for interesting discussion, goes beyond the scope of this paper. Perhaps it will become feasible to disentangle the two effects when longer time series data become available for estimation.

Secondly, we have very limited understanding of the interaction of networking with the Covid-19 recession on SME performance. This is important because past research (not focused on Covid-19) suggests that networking can improve firm performance for a number of reasons: (i) networks can enhance knowledge exchange, which can help firms overcome their inadequate learning ability by providing them with access to shared skills and information/knowledge (Nelson and Winter, 1982); (ii) the business partners in a network tend to support both each other and the network (Inkpen, 1998); and (iii) knowledge exchange influences higher growth and improves the performance of SMEs (e.g., Gils and Zwart, 2004; Lechner et al., 2006). However, in the context of the Covid-19 financial crisis, there has been very little research on the effects of networking on SME performance, especially in the UK.

Thirdly, although the Covid-19 financial crisis negatively affected thousands of enterprises across the globe (e.g., Brown and Cowling, 2021; Farsalinos et al., 2021), its impact was not equal across the regions of a country (Brown and Cowling, 2021). This is likely because different locations have different capabilities to cope with unexpected shocks (Martin, 2018). For example, a study by Brown and Cowling (2021) in the UK has found that Covid-19 had an uneven impact on firms across different UK regions. More precisely, they found that in 2021, there were very high concentrations of firms that were at risk of failure in the North Eastern parts of England compared with the Southern part of England. This suggests that there may be regional differences in the financial constraints that firms experienced and in firms' inculcated agility to adapt. However, we have very limited understanding of any regional differences in how the Covid-19 financial crisis impacted the performance of SMEs.

This paper attempts to address the above research gaps. To do this, we use longitudinal data from the '*UK Longitudinal Small Business Survey 2015-2021*' to test how innovation, network advice, financial obstacles, and several other factors associate with SMEs' performance, while controlling for the Covid-19 recession. The results show that Covid-19 affected firm performance negatively but that the effect is moderated by SME innovation in that the negative relationship is weaker for innovative firms compared with non-innovative ones. In line with prior research, we argue that during a recession period, such as that triggered by Covid-19, SMEs that can strategically deploy their limited resources to generate innovation can avoid lagging behind their competitors and thus stay in the marketplace (e.g., Wang et al., 2020; Ebersberger and Kuckertz, 2021). Moreover, the results show that SMEs located in peripheral regions of the UK were more

negatively affected by the Covid-19 recession than those in core regions (i.e., London and the South East).

The rest of the paper is organised as follows. Section 2 presents the literature review and identifies new research issues. Section 3 develops the conceptual framework and hypotheses. The methodology is explained in section 4, and section 5 presents the results and discusses the findings. Finally, section 6 concludes the paper and explains the theoretical and practical implications.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Generally, an unexpected macro-level event or crisis which is followed by a high level of economic uncertainty will have significant effects on firms' operations (e.g., Bundy et al., 2017; Klöckner et al., 2023). There are two principal theoretical perspectives about the effects of financial crisis on enterprises: the 'resilience' and 'vulnerability' views (e.g., Kitching et al., 2009; Yaya et al., 2022).

The vulnerability view sees firms as being highly vulnerable to external shocks, which are considered to have significant negative effects on their performance. Shocks result in declining profits, increasing the probability of exit for financially constrained firms (Smallbone et al., 1997). Research adopting the vulnerability perspective suggests that periods of financial crisis affect enterprises negatively because of heightened levels of instability and uncertainty, thereby creating a hostile environment that threatens enterprise survival (Herbane, 2010). Prior research has found empirical support for this presumption, finding that periods of financial crisis, such as recessions, have adverse effects on firms' sales and profitability (e.g., Irvine and Anderson, 2004; Herbane, 2010).

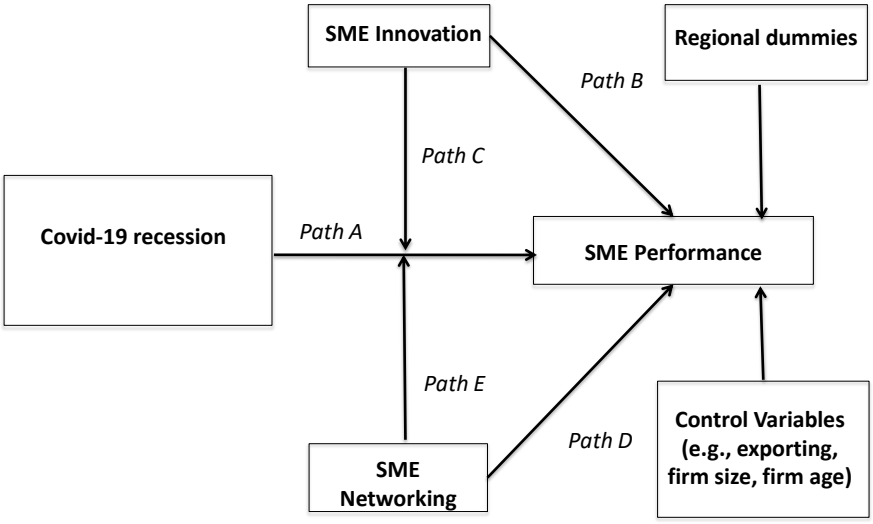
However, the vulnerability view has been questioned by researchers who promote the resilience view of enterprises (Kitching et al., 2009; Yaya et al., 2022). Resilience adherents view enterprises as having the resilience to survive financial crisis because they are able to diversify their product and service offerings through innovations, and they can also build resilience through formal and informal networks (e.g., Love and Roper, 1999; Florin et al., 2003; Idris and Saridakis, 2018; Yaya et al., 2022). Periods of economic shock can therefore create opportunities for firms (Davidsson and Gordon, 2016). Hence, some researchers argue that economic crises trigger innovation, especially in new, small, fast-growing enterprises (Archibugi et al., 2013a). Thus, instead of being devastated by the negative effects of economic crises, enterprises can survive

and enhance their performance by using a variety of strategic approaches to react to the new situation (Kabir and Abubakar, 2022).

There is a robust body of research which finds that in many countries, enterprises have indeed shown some resilience to the negative impacts of Covid-19. Kabir and Abubakar (2022) examined the impact of Covid-19 lock-down policies on ethnic minority businesses in Nigeria and find that these businesses are vulnerable to lockdown policies. However, they also find that entrepreneurial orientation reduced the hostile effects of the lockdown policies, improving the enterprises' survival chances. In Indonesia, Yaya et al. (2022) studied the innovation-driven diversification strategies that can influence enterprise survival in the period of financial crisis triggered by Covid-19, and find that unrelated diversification is the major strategy that influences the survival of enterprises. Other studies focus on the impact of innovation (e.g., Adam and Alarifi, 2021; El Chaarani et al., 2022), financial culture (Toth et al., 2022), strategies (Klyver and Nielsen, 2021) on the performance/survival of SMEs during the Covid-19 financial crisis.

However, a number of questions remain unanswered. For example, does innovation weaken the negative effect of Covid-19? This is important because innovation, along with other potential strategies such as networking, can be a way of keeping firms competitive and minimizing their probability of exiting the market during times of uncertainty (Yaya et al., 2022). Also, how did different regions withstand the effects of Covid-19 recession? Again, this is important because innovation and networking across regions can differ and it is important to capture regional effects by controlling for these variables in the specification (see Acs, 2002; Abubakar and Mitra, 2017). In Figure 1, we outline the proposed theoretical framework of this paper, which we now discuss by reference to the five identified effect paths.

Figure 1. The conceptual foundation.



2.1. Path A: the direct effect of Covid-19 financial constraints on SME performance

The Covid-19 recession is considered to be one of the most severe crises the world has experienced since World War II (Gössling et al., 2020). In terms of its effect on SMEs, studies suggest that the self-employed were affected more than those who are employed, and that small firms suffered more than larger firms (e.g., Kritikos et al., 2020; Belitski et al., 2022). For example, numerous enterprises (especially firms that are less technologically adept or have less online presence) experienced both cash-flow problems and a considerable drop in the demand for their goods and services (Bartik et al., 2020), causing many of them to shut down their operations (Cowling et al., 2020). In the UK, research suggests that the emergence of Covid-19 in 2020 put nearly 10% of the country's businesses at risk of failure because they were holding inadequate reserves (Cowling et al., 2020). Similarly, in the US, research suggests that almost 45% of SMEs ceased operating (sometimes only temporarily) or considerably reduced their employment size because of Covid-19 (Bartik et al., 2020). Further, estimates by the Organisation for Economic Co-operation and Development (OECD) suggest that over half of SMEs were affected by a loss of revenue because of the Covid-19 recession (OECD, 2020).

Crises such as Covid-19 can impose several financial constraints on firms, including cash flow interruption and a lack of access to capital (Runyan, 2006). Economic recessions can also negatively affect enterprises because of the greater instability and economic uncertainty in the business environment, which can threaten the survival of firms (Herbane, 2010). For example, in the 1990s, economic downturns had adverse effects on the sales growth and profitability of enterprises (Smallbone et al., 2012). Economic recessions can also force enterprises, particularly small firms, to cut their workforce and reduce their expenditure, which may sometimes lead to business closure (Irvine and Anderson, 2004). These arguments allow us to propose the following hypothesis:

H1: *The Covid-19 recession dummy is negatively associated with SME performance*.

2.2. Paths B and C: The direct effects of innovation (Path B) and its interaction effects with the Covid-19 dummy (Path C) on SME performance

Previous research in the innovation field argue that innovation is an important tool that allows firms to gain competitive advantages, thereby improving their financial and non-financial performance and productivity, and enhancing the overall growth of the economy (Schumpeter, 1934; Romer, 1990; Bourke and Roper, 2017; Liu et al., 2017; Yunis et al., 2018; Lee and Trimi, 2021; Mabenge et al., 2022). Previous research finds ample evidence that introducing innovation has a positive effect on small firm's performance (e.g., Gunday et al., 2011; Kostopoulos et al., 2011; Azar and Drogendijk, 2014; Makanyeza and Dzvuke, 2015).

Moreover, innovation is viewed as an important revenue-generating economic activity that can positively affect the survival of enterprises in time of economic uncertainty (Mangani and Tarrini, 2017). Hence, some studies have focused on the role that innovation played in enhancing the resilience of enterprises during the Covid-19 pandemic. These studies are often in line with the Schumpeterian view, which argues that recessions are periods of downturn in the economic activities of a country that tend to create opportunities for innovators and entrepreneurs (Schumpeter, 1934). Schumpeter sees external shocks as periods of 'creative destruction', which are times when old industries, technologies, and products go into decline, and new industries, technologies, and products emerge (Schumpeter, 1934). Hence, enterprises often employ innovation as a tool for generating revenue, which can boost their resilience and especially their chances of surviving a recession (Mangani and Tarrini, 2017). This is because innovation creates new demand and often allows enterprises to gain temporary monopolistic sales and profits (e.g.,

Niefert, 2005; Goedhuys and Sleuwagen, 2010). Therefore, it has been suggested that innovation became an essential tool for firm sustainability during the pandemic (Stoll, 2020).

Early research on the Covid-19 pandemic suggests small innovative entrepreneurial firms are '*pivoting and aiming to exploit the emerging entrepreneurial opportunities*' (Ebersberger and Kuckertz, 2021: 124). For example, in the UK, a study by Ozdemir et al. (2022) suggests that innovation is relevant to the resilience of supply chains. Also in the UK, Brown and Cowling (2021) find unequal impacts of Covid-19 crises on the peripheral and poorer northern parts of the UK, which had weaker levels of regional resilience (including innovation and human capital). Outside of the UK, Yaya et al. (2022) find that innovation is important to helping firms become resilient because it allows them to diversify their products and services into new revenue generating sectors (Yaya et al., 2022). Also, Kabir and Abubakar (2022) find in a study of ethnic minority enterprises in Nigeria that entrepreneurial orientation (including innovation) is a crisis response strategy that has significant positive effects in reducing the adverse effects of lockdowns and enhancing the resilience of enterprises during the Covid-19 economic recession.

Although it has been suggested that a crisis might produce a negative impact on the overall innovative activities of economies (Filippetti and Archibugi, 2011; Brem et al., 2020; Dachs and Peters, 2020), it has also been noted that a crisis may allow new firms to enter the market and cater to customers' demands with solutions that are more innovative than those of the existing enterprises (Archibugi et al., 2013a, 2013b). However, firms that lack innovative activities will, especially during recession, lag behind their counterparts in terms of benefiting from the innovative landscape (Ebersberger and Kuckertz, 2021). Therefore, since previous research considers that innovation is a critical driver of firms' success through a recession, '*reducing innovation expenditure to protect the core business activity would thus be myopic*' (Ebersberger and Kuckertz, 2021: 124).

Previous literature in the innovation field has produced mixed evidence on how firms' innovative activities are affected during a crisis (i.e., the cyclical or counter-cyclical nature of innovation) (e.g., Filippetti and Archibugi, 2011; Ebersberger and Kuckertz, 2021). For example, Ebersberger and Kuckertz (2021: 124) suggest that the Covid-19 crisis and recession produced a necessity for 'counter-cyclical innovation'. Arguing from the crisis literature point of view, previous research in the field has emphasised that firms draw on their innovative capabilities to ensure their survival, growth, and renewal (e.g., Champion, 1999; Lawson and Samson, 2001; Danneels, 2002; Wang

et al., 2020). This is because the financial constraints created by economic crisis tend to push firms to look for new innovations as a means of survival (e.g., Yaya et al., 2022; Kabir and Abubakar, 2022), which can positively improve their performance (e.g., Niefert, 2005; Abrishamkar et al., 2021). Thus, in periods of financial crisis, innovative SMEs can create new revenues. This enhances their resilience, especially if the innovation creates new demand that allows the firm to earn temporary monopolistic profits, which positively affect performance (e.g., Niefert, 2005; Mangani and Tarrini, 2017; Yaya et al., 2022). Putting these arguments together, we hypothesise the following:

$H2_a$: *Innovation is positively associated with SME performance*.

$H2_b$: *The interaction effect of innovation with the Covid-19 recession dummy will be positive and strongly associated with SMEs' performance*.

2.3. Paths D and E: The direct effects of networking (Path D) and its interaction effects with the Covid-19 dummy (Path E) on SME performance

Existing research generally acknowledges that '*entrepreneurial activity is embedded in network relationships*' (Stam et al., 2014: 153) from which firms can gain access to knowledge, advice, resources, and information (e.g., Aldrich and Zimmer, 1986; Hoang and Antoncic, 2003). Previous research in the field emphasises that the social capital gained from network relationships plays a role in enabling firms and entrepreneurs to discover and exploit opportunities, influencing their success and increasing firm's legitimacy (Adler and Kwon, 2002; Batjargal, 2003; Elfring and Hulsink, 2003; Stam et al., 2014).

Networks refer to collaborations among individuals and organizations (Dubini and Aldrich, 1991; Kreiner and Schultz, 1993), which can give access to resources (Nahapiet and Ghoshal, 1998: 243). Successful SMEs tend to be operated by individuals who put their energy and time into network development (Dubini and Aldrich, 1991). Thus, past research suggests that networking is important for accessing resources (Hansen, 1991), and can therefore influence the survival of businesses (Carlisle and Flynn, 2005). Following the resource-based view, which considers resources to be '*tangible and intangible assets which are tied semi-permanently to the firm*' (Wernerfeldt, 1984: 172), it can be argued that firms with superior resources will gain sustained competitive advantages. Not all resources can offer firms competitive advantage (Parida et al., 2010), and it can be argued that the scarcer (and thus more valuable) resources may be accessed

through networking relationships. Hence networks are deemed to be important for firms, and especially so for small firms (e.g., Pittaway et al., 2004; Parida et al., 2010). Through networking, firms can gain access to resources, suppliers, customers, competitors, and collaborate in R&D activities, which can in turn enhance their competitive advantages and the likelihood of their survival during uncertainty.

Seeking advice can be considered to be a facet of networking, and the association between seeking advice and firm performance has received significant attention from previous research. While some studies have questioned whether firms obtain advantages from seeking advice, other studies have provided ample evidence for its benefits (e.g., Coad et al., 2016; Mole and Capelleras, 2017; Cole and Fernando, 2021; McKenzie, 2021; Jibril et al., 2022). For instance, Idris and Saridakis (2018) show that SMEs that seek external advice have a higher likelihood of internationalisation than their counterparts. Moreover, it has been argued that through networking opportunities, firms can gain access to '*valuable and specialized knowledge*' which can complement their lack of resources (Adler and Kwon, 2002; Parida et al., 2010: 1).

Despite evidence for the positive benefits of seeking external advice and networking, SMEs are often reluctant to engage in networking activities or seek advice from external sources (Jibril et al., 2022). However, even the most reluctant small firm may push itself to seek advice when it is facing significant challenges for which its own experience, expertise, and internal resources might not be beneficial, efficient, or effective (Johnson et al., 2007). For example, Mole (2016) found that '*SMEs often require a trigger event to push to seek external advice*' (Jibril et al., 2022: 3). In addition, it has been suggested that external advice has been found to provide owners of small firms with psychological and emotional support, which is important during times of recession (e.g., Mole, 2016; Kuhn et al., 2017; Jibril et al., 2022). We are motivated by this evidence to suggest that network advice has a positive effect on small firms' performance. In addition, we argue that during the Covid-19 recession, firms that sought external advice were likely to outperform firms that did not seek external advice. Put together, we hypothesise the following:

H3$_a$: *Network advice is positively associated with SME performan*ce.

H3$_b$: *The interaction effects of network advice with the Covid-19 recession dummy will be positive and strongly related to SME performance*.

3. DATA USED IN THE STUDY

We use data from the '*UK Longitudinal Small Business Survey 2015-2021*', produced by the UK's Department for Business, Energy, and Industrial Strategy (BEIS, 2022a). There are seven years in the longitudinal data, and it covers SMEs located across four regions in the UK – England, Wales, Scotland, and Northern Ireland. The sampling frame is a combination of the Inter-Departmental Business Register (for employers/VAT-registered companies) and the Experian database (for unregistered businesses with no employees). The sample is stratified by UK region, sector, and size. The sample for Scotland and Northern Ireland is boosted and is disproportionate in terms of business size.

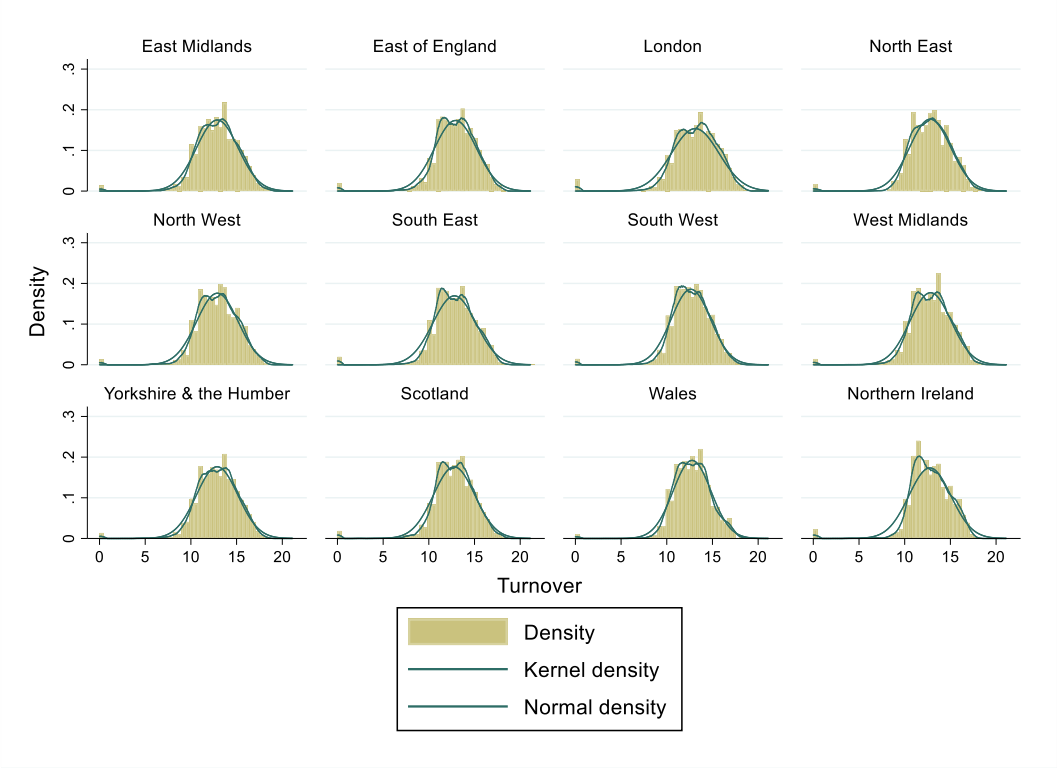
The questionnaire requests considerable information regarding the operations of SMEs (see BEIS, 2022b technical report for more information). For example, it surveys firms on their turnover, number of employees, the constraints they face, trading activities, innovation activities, the effect of Covid-19 on the business, their networking activities (in the relevant years), and their future intention. More specifically, the survey asks owner-mangers of small firms if they are facing any obstacles to obtaining finance, if they have introduced innovation in the past 3 years, if they sought external advice from outside sources, and their annual turnover. This information can be extracted at the regional level.

3.1 Variables used in the model

3.1.1. The dependent variable: firm performance

In this paper we measure firm performance by growth in turnover (e.g., Bartel, 1994; Robson and Bennett, 2000). We use the natural log of turnover as a proxy of firms' performance, and deal with zero values by using a log (y+1) transformation. The survey asks owner-mangers the following question: '*Can you please tell me the approximate turnover of your [business name] in the past 12 months across all your UK sites? – To clarify, turnover is the total income received by the business from all sales of goods and services charged to third parties*' (BEIS, 2022b: 89). Figure 2 shows the Kernel density estimated distribution of turnover by region. Generally, the graphs show that most values are centrally concentrated, and thus the turnover series approximates normality.

Figure 2. Kernel density estimated distribution of turnover by region.



3.2.2. The independent variables: Covid-19, innovation, networks, and control variables

Covid-19 recession

Covid-19 induced a global recession, the first major sign of which was the 2020 stock market crash. There was an unprecedented drop in GDP during the UK's first pandemic-related lockdown. In April 2020, the UN predicted that unemployment would wipe out 6.7% of global working hours, which is equivalent to 195 million full-time workers. In the UK, the Covid-19 recession saw unemployment shoot to an unusual high; by 2020, over 11.7 million jobs had been furloughed. SMEs were particularly hard hit because they had varied expectations of the crisis duration, tended to operate cash in hand (which indicates financial fragility), and responded cautiously to the government's interventions. We capture such potential effects of Covid-19 on firm performance by creating a dummy variable, which takes the value of one during the Covid-19 years (i.e., 2020-2021), and zero otherwise. We expect the Covid-19 dummy to carry a negative sign in the model.

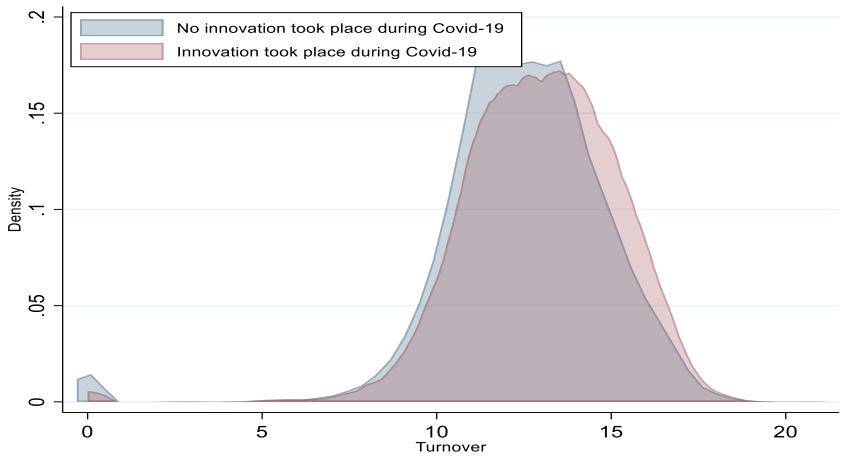
Innovation

According to the Oslo Manual (OECD, 2005: 46), innovation is '*the implementation of new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations*'. The survey asks owner-managers the following questions regarding their innovative activities: 1) '*Has your [business name] introduced any new or significantly improved goods in the past three years*'; 2) '*Has your [business name] introduced any new or significantly improved services in the past three years*'; and 3) '*Has your [business name] introduced any new or significantly improved processes for producing or supplying goods or services in the last three years*' (BEIS, 2022b: 78).

We follow previous research in the field (Nguyen et al., 2008; Chetty and Stangl, 2010; Higón and Driffield, 2010; Chiva et al., 2014; Golovko and Valentini, 2014; van Beers and Zand, 2014; De Massis et al., 2015; Abubakar et al., 2019; Saridakis et al., 2019; Idris et al., 2022), and create an index variable that captures whether firms have introduced any type of innovation (i.e., a good, service, or process).[3] Hence, our independent variable is a binary variable that takes the value of one if the firm introduced any type of innovation, and zero otherwise. As already discussed, we expect the innovation variable to have a positive and statistically significant effect on firm performance. Also, we expect that innovation helped firms overcome the negative effect of Covid-19, allowing them to achieve better performance than the firms that did not innovate during Covid-19. Figure 3 below shows the Kernel density estimated distribution of turnover during Covid-19 for firms that undertook innovation and those that did not. The comparison suggests a positive impact of innovation on SME performance.

[3] Previous research has shown that there are disparities in levels of R&D by region. For example, a report by Flaherty (2023) suggests that half of the public funding for R&D is spent on London and the South East regions, and that when it comes to firm-level R&D, these regions take even a greater share (Flaherty, 2023).

Figure 3. Kernel density estimated distribution of turnover for innovative and non-innovative SMEs during Covid-19.



Networks

It has been implied that advice networks '*involve relationships where individuals share resources and obtain support and information*' (Sparrowe et al., 2001; Idris and Saridakis, 2018: 611). We follow previous research in the field and use 'external advice' as a proxy of firms' networking activities (Hoang and Antoncic, 2003; Idris and Saridakis, 2018). The survey asks the owner-managers of small firms: '*In the last 12 months have you sought external advice for information on matters affecting your [business name]*' (BEIS, 2022b: 81). This explanatory variable is a binary variable which takes the value of one if owner-managers of small firms sought external advice, and zero if not. Our variable captures both formal and informal networks, including advice from accountants, banks, lawyers, Chamber of Commerce, business networks, and family and colleagues, among others. Table 1 shows that there is a significant difference in performance between SMEs that use network advice and those that do not use network advice, although Covid-19 affected both types of SME negatively.

Table 1. SME performance with and without network advice before and during Covid-19.

	No network	Network	Difference
Before Covid-19	12.566	13.344	0.778***
	(0.027)	(0.039)	(0.048)
During Covid-19	12.431	13.126	0.694***
	(0.047)	(0.072)	(0.088)
Difference	-0.134**	-0.217***	
	(0.052)	(0.079)	

Notes: *** denotes significant at 1%, and ** at 5%. Standard errors are reported in parenthesis. Performance is measured as turnover (in log).

Control variables

The survey also allows us to control whether a firm faced a financial obstacle. Specifically, the survey asks, '*Which of the following would you say are major obstacles to the success of your [business name] in general?*' (BEIS, 2022b: 66). From this question, a binary variable is created that takes the value of one if firms face financial obstacles, and zero otherwise. We include this variable in the model and also interact it with the Covid-19 recession to examine whether financial obstacles were magnified during the Covid-19 recession. Moreover, we control for the following variables that might affect firm performance: the size of the firm measured as the natural log of the number of employees (Idris et al., 2023), the age of the business measured as the natural log of the number of years the business has been in operation (Bennett and Robson, 1999), and whether the firm is engaged in exporting activities, which is a binary variable that takes the value of one if the firm exports any goods and/or services outside the UK, and zero otherwise. We also control for the legal status of the firm, its sector, and the region. Finally, we include a variable for whether the firm is located in a rural or urban area.

4. ECONOMETRIC APPROACH

Given the nature of our data (which combines time with cross-section data for SMEs), the panel regression data method is most suitable natural estimation environment. In particular, we model SME firm performance, $\log(turnover)_{i,t}$ (for *i*-th firm at time *t*) by Covid-19 (a dummy variable that takes the value of one in the years 2020 and 2021), innovation (a dummy variable that takes the value of one if the firm innovates), networks (a dummy variable that takes the value of one if the firm makes use of any type of formal and/or informal advice), and their various interactions. We use several control variables (X). The firm fixed effects are captured by μ_i. The term, $e_{i,t}$ is assumed to be white noise (normally distributed with no serial correlation and no heteroscedasticity).

$$\log(turnover)_{i,t} = \beta_1 Covid_t + \beta_2 Innovation_{i,t} + \beta_3 Networks_{i,t} + \beta_4 Covid_t * Z_{i,t} + \beta_5 X_{i,t} + \mu_i + e_{i,t} \quad \text{(Eq. 1)}$$

We expect the coefficient of Covid-19 to be negative (β_1), whereas the innovation and networks coefficients are expected to be positive (β_2 and β_3, respectively). When we interact the latter two variables with Covid-19, we expect the interaction coefficients to carry a positive sign (β_4). We have followed the literature in using financial obstacles, exporting, traditional firm-level demographics (firm size and age), and regional controls. Table A1 in the appendix shows the summary statistics of the main variables used in the regression analysis, and Table A2 (also in the appendix) shows the correlation matrix between the variables. Briefly, Table A2 shows that Covid-19 has a negative correlation with SME performance whereas innovation and network advice are positively associated with SME performance.

We estimate equation (1) using both fixed and random effects methods. A Hausman specification guides our choice between the two. Moreover, separate models are estimated for various regions to account for regional differences in the SME performance model. Finally, we also attempt to estimate a model that allows for a dynamic adjustment. Hence, a lagged value of the dependent variable is included in the model, and a generalized method of moment (GMM) estimator is used to estimate the model and to deal with potential endogeneity issues.

5. EMPIRICAL RESULTS

In Table 2 we present the analysis from the regression models (Models I–IV). Model I provides estimates for pooled, random, and fixed effects. Focusing on the first column of Model I, the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity suggests potential heteroscedasticity presence in the model [$x^2(1)$ =1995.24, p< 0.001] and thus, robust standard errors have been used to deal with this. The link tests suggest there is no specification error (i.e., the prediction squared does have explanatory power, p=0.205). The mean variance inflation factor ($\overline{VIF}$) is 5.38, which does not raise concerns about multicollinearity. Turning to the second column of Model I, the Breusch and Pagan Lagrangian multiplier test for random effects suggests that the random effects model is more appropriate than the pooled model [x^2(1) =1168.38, p< 0.001]. Finally, we find that the Hausman is too large and thus the use of a fixed effect model, presented in column 3 of Model I, is more appropriate [x^2(2) =344.13, p< 0.001]. We repeat these tests when we estimate Models II-IV, and since the overall conclusions remain unchanged, we do not report the

test statistics for these subsequent models. We therefore now discuss the findings from the models.

All models suggest that Covid-19 recession is negatively and statistically significant associated with SME performance; hence we find evidence for our **H1**. Our results are in line with previous literature which indicates that a negative external economic shock has an adverse effect on small firms (Bundy et al., 2017; Klöckner et al., 2023). Also, the results show that innovation has a statistically insignificant effect on SME performance (see Model I); hence we do not find support for our $\mathbf{H2_a}$.[4] However, when innovation interacts with Covid-19 (see Model II), the interaction effect is found to be positive and statistically significant. This supports our $\mathbf{H2_b}$ by indicating that firms that were innovative during Covid-19 outperformed those that did not introduce any type of innovation (see also Figure A1 in Appendix). The results support and complement previous literature, suggesting that innovation can be an important tool for firms' resilience and survival by reducing the negative effect of external shocks, allowing firms to remain competitive in the marketplace (e.g., Ebersberger and Kuckertz, 2021; Kabir and Abubakar, 2022; Yaya et al., 2022). Hence, we agree with the suggestion of Ebersberger and Kuckertz (2021: 124) that the Covid-19 recession has produced a necessity for 'counter-cyclical innovation', in that firms must reduce its negative effect.

[4] We also use a propensity score matching technique to account for potential selection bias. We create a dummy that takes the value of one if the firm carried out innovation during Covid-19 (treated firms), and zero otherwise. The results are shown in Table A3 in the appendix (a normal kernel is used). It shows that the difference in performance between treated and control groups is found to be small but positive, suggesting that firms that undertook innovation perform better than firms that did not innovate during Covid-19. When we restricted the sample to English regions, the difference remained small and positive.

Table 2. Impact of Covid-19 on SME firm performance (including all countries: England, Wales, Scotland and Northern Ireland).

	Model I			Model II			Model III			Model IV		
Variables	OLS	RE	FE	OLS	RE	FE	OLS	RE	FE	OLS	RE	FE
Covid-19	-0.246***	-0.214***	-0.202***	-0.269***	-0.252***	-0.252***	-0.248***	-0.205***	-0.182***	-0.261***	-0.225***	-0.210***
	(-8.147)	(-7.913)	(-5.353)	(-6.706)	(-6.801)	(-4.910)	(-6.804)	(-6.676)	(-4.568)	(-8.165)	(-7.684)	(-5.064)
Innovation	-0.017	0.024	0.051	-0.034	-0.003	0.013	-0.017	0.024	0.051	-0.017	0.024	0.052
	(-0.675)	(1.057)	-1.596	(-1.176)	(-0.129)	(0.397)	(-0.675)	(1.057)	(1.595)	(-0.677)	-1.063	-1.603
Covid-19xInnovation				0.063	0.101**	0.137**						
				(1.073)	(1.996)	(2.109)						
Network advice	0.125***	0.064**	-0.028	0.125***	0.064**	-0.029	0.123***	0.071***	-0.008	0.124***	0.063**	-0.029
	(4.548)	(2.444)	(-0.725)	(4.543)	(2.442)	(-0.737)	(3.988)	(2.783)	(-0.244)	(4.524)	-2.42	(-0.736)
Covid-19xNetwork advice							0.008	-0.029	-0.074			
							(0.123)	(-0.516)	(-1.011)			
Financial obstacle	-0.247***	-0.199***	-0.134***	-0.247***	-0.199***	-0.135***	-0.247***	-0.199***	-0.134***	-0.270***	-0.217***	-0.146***
	(-6.620)	(-5.789)	(-2.764)	(-6.610)	(-5.780)	(-2.777)	(-6.618)	(-5.788)	(-2.761)	(-6.522)	(-5.779)	(-2.767)
Covid-19xFinancial obstacle										0.106	0.082	0.061
										-1.178	-1.211	-0.879
Exporting	0.495***	0.418***	0.141	0.495***	0.420***	0.144	0.495***	0.418***	0.142	0.495***	0.419***	0.141
	(18.787)	(12.568)	(1.587)	(18.777)	(12.621)	(1.622)	(18.789)	(12.569)	(1.588)	(18.794)	-12.565	-1.584
ln(Sites)	0.478***	0.380***	0.188	0.479***	0.379***	0.181	0.478***	0.379***	0.188	0.477***	0.378***	0.184
	(4.729)	(4.017)	(1.196)	(4.729)	(4.003)	(1.153)	(4.732)	(4.012)	(1.200)	(4.725)	-4.008	-1.174
ln(Sites)^2	-0.116***	-0.087***	-0.035	-0.116***	-0.087***	-0.034	-0.116***	-0.087***	-0.035	-0.116***	-0.087***	-0.034
	(-3.623)	(-3.219)	(-1.334)	(-3.615)	(-3.189)	(-1.276)	(-3.624)	(-3.215)	(-1.337)	(-3.620)	(-3.212)	(-1.305)
ln(Firm size)	1.023***	0.927***	0.356***	1.023***	0.928***	0.360***	1.023***	0.927***	0.356***	1.022***	0.927***	0.356***
	(33.232)	(25.312)	(3.843)	(33.238)	(25.308)	(3.874)	(33.223)	(25.324)	(3.849)	-33.199	-25.299	-3.839
ln(Firm size)^2	-0.010*	0.006	0.001	-0.010*	0.006	-0.000	-0.010*	0.006	0.001	-0.010*	0.006	0.001
	(-1.731)	(0.841)	(0.043)	(-1.733)	(0.831)	(-0.010)	(-1.733)	(0.847)	(0.055)	(-1.723)	-0.848	-0.056
ln(Firm age)	0.424***	0.489***	0.805*	0.423***	0.488***	0.827**	0.424***	0.489***	0.814*	0.424***	0.489***	0.802*

	(4.027)	(4.419)	(1.929)	(4.024)	(4.414)	(1.982)	(4.027)	(4.422)	(1.951)	-4.031	-4.419	-1.92
ln(Firm age)^2	-0.046**	-0.054***	-0.120	-0.046**	-0.053***	-0.128	-0.046**	-0.054***	-0.122	-0.046**	-0.053***	-0.12
	(-2.554)	(-2.801)	(-1.459)	(-2.551)	(-2.796)	(-1.568)	(-2.555)	(-2.804)	(-1.481)	(-2.555)	(-2.797)	(-1.454)
Company	0.693***	0.735***	-0.526*	0.693***	0.735***	-0.521*	0.693***	0.735***	-0.525*	0.694***	0.735***	-0.525*
	(14.763)	(13.438)	(-1.694)	(14.764)	(13.456)	(-1.702)	-14.751	-13.423	(-1.688)	(14.774)	-13.452	(-1.695)
Partnership	0.661***	0.677***	-0.235	0.662***	0.678***	-0.241	0.661***	0.678***	-0.23	0.662***	0.678***	-0.24
	(11.862)	(10.829)	(-0.770)	(11.864)	(10.846)	(-0.796)	(11.871)	(10.840)	(-0.750)	(11.883)	-10.835	(-0.783)
Other	0.383***	0.434***	-0.490	0.382***	0.432***	-0.505	0.383***	0.433***	-0.487	0.381***	0.432***	-0.495
	(3.996)	(4.196)	(-1.371)	(3.992)	(4.181)	(-1.424)	(3.993)	(4.189)	(-1.359)	(3.981)	-4.173	(-1.382)
Rural	-0.015	-0.038	-0.104	-0.015	-0.038	-0.102	-0.015	-0.038	-0.110	-0.014	-0.038	-0.104
	(-0.509)	(-1.190)	(-0.542)	(-0.509)	(-1.189)	(-0.528)	(-0.509)	(-1.190)	(-0.571)	(-0.502)	(-1.185)	(-0.541)
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	9.127***	9.117***	11.199***	9.148***	9.167***	11.326***	9.127***	9.115***	11.179***	9.130***	9.121***	11.207***
	(56.129)	(53.563)	(18.968)	(54.958)	(52.257)	(17.832)	(56.191)	(53.584)	(18.879)	(56.242)	(53.629)	(18.978)
Observations	13325	13325	13325	13325	13325	13325	13325	13325	13325	13325	13325	13325

Notes: t-statistics/z-statistics in parentheses. *p<0.1, ** p<0.05, *** p<0.01.

Moreover, the results tend to suggest that network advice is positively associated with SMEs (this finding is supported by the pooled and random effect models), which offers support for our **$H3_a$**. To this end, the results are in line with previous research which stressed the importance and positive benefits of networking (in terms of seeking advice) for small firms (Adler and Kwon, 2002; Parida et al., 2010; Stam et al., 2014; Idris and Saridakis, 2018; McKenzie, 2021; Jibril et al., 2022). However, when the network variable is interacted with the Covid-19 variable (Model III), the interaction effect is found to be statistically insignificant, providing no support for **$H3_b$.** That being said, our measure of networks is very specific and does not capture the strength of network collaboration. We therefore cannot capture how the intensity of collaboration between networks changed over the Covid-19 pandemic and whether or not this is associated with SME performance.

We extract other interesting findings. Table 2 shows that financial obstacles carry a negative and statistically significant coefficient. Our results are in line with previous research that finance is considered to be a critical factor for small firms' growth and performance (Cook and Nixson, 2000; Guariglia et al., 2011; Moscalu et al., 2020). We also interact this variable with the Covid-19 recession dummy (Model IV), but the interaction coefficient is found to be negative and statistically insignificant. Perhaps this counter-intuitive finding can be explained by the UK government's introduction of financial support schemes such as small business grants, Bounce Back Loans, etc. (see Pope et al., 2020; Rostamkalaei et al., 2023). We also find some statistically significant coefficients for several other variables (e.g., exporting, firm age, firm size, the type of firm, industry) confirming the association with SME performance that prior literature has noted.[5]

5.1. Sub-sample regional estimates

In this section we draw on the theory of knowledge spillover, which suggests that spatial relationships are important to an enterprise's ability to generate from external factors the new knowledge needed for innovation (Acs 200; Abubakar and Mitra, 2017). Knowledge spillovers (especially those related to R&D) enable enterprises that are close to important sources of knowledge (such as competitors, collaborators, universities) to create new innovations more

[5] We also run various models for several other interactions such as network advice and financial obstacle, and innovation and financial obstacles. But these models were generally sensitive to specifications and controls, and thus are not reported here.

quickly than their competitors who are located in peripheral regions (where there may be a dearth of local knowledge sources) (Breschi and Lissoni, 2001).

The literature on localised knowledge spillovers suggests that firms that are located in regions experiencing higher levels of spillovers of knowledge, especially from regional businesses and universities are more likely to have better firm performance (Audretsch and Lehmann, 2005; Audretsch and Dohse, 2007; Raspe and van Oort, 2008; Abubakar and Mitra, 2017). Knowledge spillovers can positively affect firm performance because the spillover of knowledge influences innovation (Acs, 2002), which positively influences firm performance by creating new demand, allowing firms to conquer their markets at the expense of their competitors (Niefert, 2005). Knowledge spillovers are particularly important for SMEs because of their greater need to complement their internal resource constraints with the external knowledge resources available in their environments (Acs, 2002). Therefore, since knowledge spillovers influence innovation (Jaffe, 1989; Acs, 2002) and innovation positively affects firm performance (Niefert, 2005), we can expect that the firms that are located in regions with greater knowledge spillovers are more likely to have better performance. For example, Audretsch and Lehmann (2005) found that university knowledge spillovers have a positive effect on firm performance. Similarly, Audretsch and Dohse (2007) found that locational characteristics (such as agglomeration and knowledge resources) have a positive influence on firm performance. In addition, Abubakar and Mitra (2017) found that regional knowledge spillovers can positively affect firm performance. Taken together, these suggest that firms that are located in regions with high levels of R&D and associated knowledge spillovers (i.e., core regions) are more likely to have better performance compared with regions with low/non-existent R&D and few knowledge spillovers (i.e., peripheral regions).

To unpack some regional differences, we control for England's regions in the specification (with the reference category being London). In Table 3, we present the results, which confirm the findings discussed earlier. It can be seen that the Covid-19 recession is negatively associated with SME performance for both the peripheral and core regions. Interestingly, we find the interaction coefficient between Covid-19 recession and innovation to be positive and statistically significant for the peripheral regions only. This may suggest that innovation played a significant role in keeping peripheral firms in business during Covid-19.

Table 3. OLS regression results for England.

Regression	All	Peripheral regions	Core regions
ln(Turnover$_{t-1}$)	0.735***	0.694***	0.815***
	(18.002)	(13.513)	(13.507)
Covid-19	-0.190***	-0.191***	-0.182**
	(-4.563)	(-3.805)	(-2.480)
Innovation	0.002	0.006	-0.002
	(0.074)	(0.191)	(-0.042)
Covid-19xInnovation	0.168***	0.179***	0.162
	(2.996)	(2.715)	(1.524)
Network advice	0.080***	0.057*	0.121***
	(3.234)	(1.877)	(2.674)
Financial obstacle	-0.049	-0.038	-0.058
	(-1.400)	(-0.831)	(-1.235)
Regions (ref. cat. London)			√
East Midlands	-0.145**	√	
	(-2.498)		
East of England	-0.070	√	
	(-1.247)		
North East	-0.047	√	
	(-0.743)		
North West	-0.076	√	
	(-1.577)		
South East	-0.065		√
	(-1.427)		
South West	-0.099*	√	
	(-1.782)		
West Midlands	-0.085*	√	
	(-1.646)		
Yorkshire & the Humber	-0.093	√	
	(-1.490)		
Controls	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Constant	2.646***	2.852***	2.048**
	(5.562)	(5.541)	(2.233)
Observations	5897	4012	1885

Notes: t-statistics in parentheses. *p<0.1, ** p<0.05, *** p<0.01.

We also find that several peripheral regions underperformed compared with London (which is one of the core regions).[6] This is likely because half of all public-funded and firm-level R&D is carried-out in London and the South East regions (Flaherty, 2023). We also estimate a model interacting the Covid-19 recession with regions. However, the model is not presented here because the interactions offer no additional insight into our model, being jointly equal to zero (p= 0.455). Overall, however, it can be argued that firms in core regions are more likely to show better performance than those in peripheral regions because of the greater levels of regional knowledge spillovers (e.g., Audretsch and Lehmann, 2005; Audretsch and Dohse, 2007) which enhances their innovativeness (Acs, 2002) and by extension boosts their performance (Niefert, 2005). Also, in these models, we find an association between firm's networks and SME performance, and the effect seems to be stronger in core regions.[7]

Finally, a lagged dependent variable is included in the specification to capture the dynamic nature of firm performance. In the pooled OLS model with robust standard errors, we find the lagged value of turnover to be a strong predictor for SME performance. However, it can be argued that the $\log(turnover)_{i,t-1}$ is correlated with μ_i (see equation1). To check the robustness of the results and deal with potential endogeneity issues, we estimate a simple model using a two-step system GMM (Roodman, 2009). Following Arellano and Bond (1991) and Arellano and Bover (1995), lagged and differences of the variables are used as instruments. The Sargan and Hansen tests of instrument validity and over-identifying restrictions are used to ensure the validity of the instruments employed, and we also report Arellano-Bond test for first and second order autocorrelated disturbances in the first differences equations. The results are presented in Table 4.

Specifically, the peripheral and core regions are modelled separately and for each model; this allows us to satisfy the tests of overidentifying instruments and ensure that the model does not suffer from the serial correlation problem. As seen in Table 4, the GMM results suggest that the

[6] We also create a dummy taking the value of one if the firm is located in a peripheral region and zero if the firm is located in a core region (i.e., London or the South East). The coefficient of this dummy was found to be negative and statistically significant, indicating that firms in peripheral regions underperform compared with firms in core regions. We also interact this variable with Covid-19 but the interaction coefficient is found to be statistically insignificant.

[7] We also estimate the model using lagged firm networks to address potential endogeneity between the 'firm networks' variable and the 'firm performance' measure. The coefficients drop in magnitude but remain statistically significant for the overall sample and the core regions.

lagged performance coefficient is positive and statistically significant. For peripheral and core regions, the Covid-19 recession dummy is found to be negative and statistically significant. Interestingly, the interaction term between innovation and Covid-19 recession dummy is found to be positive and statistically significant in both models. The individual coefficient of innovation, however, is found to be statistically insignificant, which is in line with previous findings discussed here. The AR(1) and AR(2) statistics confirm that the model does not suffer from serial correlation and the Hansen and the Sargan tests both provide reassurance for the validity of the instruments.

Table 4. GMM estimates for England divided by peripheral and core regions.

Regression	Peripheral regions	Core regions
ln(Turnover$_{t-1}$)	0.469***	0.460***
	(4.584)	(4.198)
Covid-19	-1.678**	-1.684***
	(-2.056)	(-3.117)
Innovation	1.313*	-0.014
	(1.922)	(-0.046)
Covid-19xInnovation	4.709**	3.799***
	(2.107)	(3.012)
Controls	Yes	Yes
Industry dummies	Yes	Yes
P-value of AR(1)	0.001	0.000
P-value of AR(2)	0.871	0.511
P-value of Sargan test	0.198	0.482
P-value of Hansen test	0.413	0.600

Notes: t-statistics in parentheses. * $p<0.1$, ** $p<0.05$, *** $p<0.01$.

6. CONCLUSION AND IMPLICATIONS

Although existing research has examined the impact of Covid-19 crisis on SMEs (e.g., Kabir and Abubakar, 2022; Yaya et al., 2022), there has been limited research that examines the effects of the Covid-19 economic crisis in interaction with innovation and use of advice networks on SME performance, especially in the UK. Thus, this study aims to shed more light on this issue by analysing a panel of SMEs from the '*UK Longitudinal Small Business Survey 2015-2021'*. The data provides information up to most recent wave and allows us to examine the effect of Covid-19, along with the potential impact of innovation and the utilisation of networks on SMEs' performance. The results of our study generate some important contributions to knowledge. They also have policy implications, as explained below.

The paper makes an important theoretical contribution to the literature on pandemic-driven financial crisis and the resilience of enterprises (Kabir and Abubakar, 2022; Yaya et al., 2022) by providing a new theoretical conceptual framework that shows how the Covid-19 financial crisis affects SME performance (directly) and the firm-level resilience strategies of innovation and networking. Our empirical strategy uses various panel data techniques to measure and assesses the direct and interaction effects of innovation with the Covid-19 recession dummy on SME performance at regional and national level. Hence, we contribute to the literature on pandemic-driven financial crisis and resilience (e.g., Kabir and Abubakar, 2022; Yaya et al., 2022) and regional knowledge spillovers (e.g., Acs, 2002; Abubakar and Mitra, 2013, 2017) by empirically demonstrating the negative effects of Covid-19 pandemic on SME performance and highlighting some key differences between regions. In particular, innovation during Covid-19 is found to boost SME performance.

Hence, a major implication of this study is that the managers of SMEs should encourage innovation during times of economic downturn as a way of remaining competitive and boosting performance. Although both innovation and networking are important for SME performance, our study suggests that innovation is a more powerful resilience strategy for countering the negative effects of pandemic-driven financial crisis. Thus, the results also suggest that government policy makers should encourage and support innovation during periods of financial crisis. Finally, the results show that firm networks can also help SMEs boost their performance, although this effect is found to be stronger in core regions compared with peripheral ones. SMEs in core regions (e.g., London and the South East) are also more resilient to the negative effects of pandemic-driven financial crisis, which suggests that government policy makers should pay more attention to the

more vulnerable peripheral regions by giving the SMEs in those regions extra support to boost their innovation and cushion the adverse effects of pandemic-driven financial crisis. Policy makers should also consider how to enhance firm networking and collaboration between the peripheral and core regions. This can be done by, say, promoting knowledge creation, resource sharing, and information exchange between the regions. Such policies can promote regional growth and economic equality and prosperity.

Of course, this study is not without limitations. This study focused on innovation and networking as resilience strategies for countering the effects of pandemic-driven financial crisis. Thus, future studies can extend our findings by studying the effects of other resilience strategies on SME performance during periods of pandemic-driven financial crisis. Also, our study is limited to SMEs; future research could focus on large-sized enterprises and examine whether these findings hold for larger organizations with different formal structures. In addition, our study is limited to the UK context. Therefore, future research can test if the results are similar or different for other developed and developing economies.

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APPENDIX

Figure A1. The role of innovation on performance before and during Covid-19.

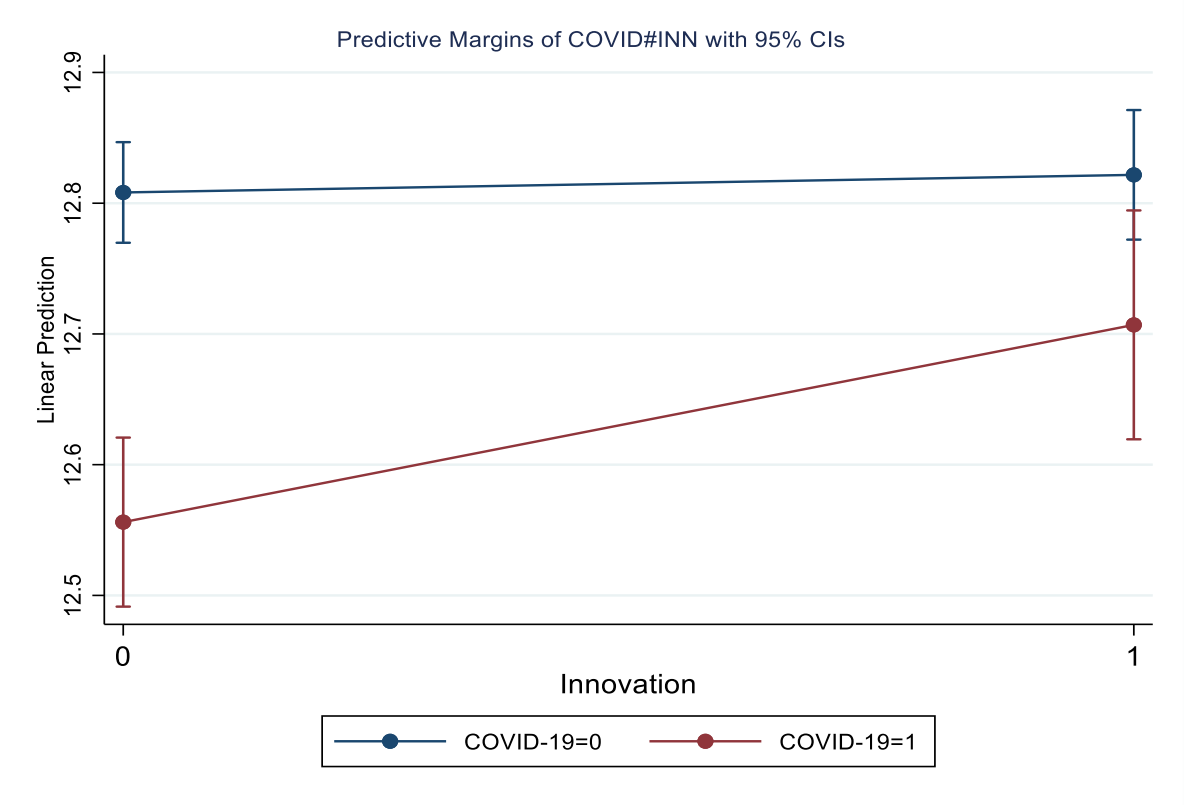

Table A1. Summary Statistics.

Variables	Mean	Std. Dev. (overall)
ln(Turnover)	12.758	2.277
Covid-19	0.275	0.447
Innovation	0.399	0.490
Network advice	0.303	0.459
Financial obstacle	0.179	0.383
Exporting	0.243	0.429
ln(Sites)	0.822	0.357
ln(Firm size)	1.850	1.540
ln(Firm age)	2.918	0.791
Legal status (ref. cat. Sole proprietorship)		
Company	0.739	0.439
Partnership	0.076	0.265
Other	0.034	0.181
Region (ref. cat. England)		
Scotland	0.104	0.305
Wales	0.044	0.206
Northern Ireland	0.040	0.196
Rural	0.300	0.458
Industry (ref. cat. Business services)		
Production and construction	0.239	0.427
Transport, retail, and food service	0.252	0.434
Other services	0.153	0.360

Notes: Obs. 13,325. The overall, between and within std. dev. of the continuous variables are: turnover (2.278, 2.299, 0.365); sites (0.357, 0.354, 0.075); size (1.540, 1.541, 0.160); age (0.791, 0.810, 0.059).

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Table A2. Correlation Matrix between key variables.

Variables	ln(Turnover)	Covid-19	Innovation	Network advice	Financial obstac	Exporting	ln(Sites)	ln(Firm size)	ln(Firm age)	Company	Partnership	Other	Scotland	Wales	Nothern Ireland	Rural	Production and construction	Transport, retail and food	Other services
ln(Turnover)	1																		
Covid-19	-0.0361*	1																	
	0,000																		
Innovation	0.1001*	-0.0551*	1																
	0,000	0,000																	
Network advice	0.1536*	-0.0334*	0.2128*	1															
	0,000	0,000	0,000																
Financial obstacle	-0,007	-0.0715*	0.0838*	0.0943*	1														
	0,408	0,000	0,000	0,000															
Exporting	0.2088*	-0.0283*	0.2025*	0.0884*	-0.0256*	1													
	0,000	0,001	0,000	0,000	0,003														
ln(Sites)	0.2698*	-0,010	0.0674*	0.0848*	0.0389*	-0,004	1												
	0,000	0,243	0,000	0,000	0,000	0,684													
ln(Firm size)	0.7403*	0,011	0.1209*	0.1771*	0.0608*	0.1150*	0.3756*	1											
	0,000	0,213	0,000	0,000	0,000	0,000	0,000												
ln(Firm age)	0.2057*	0.0349*	-0.0297*	0,007	-0.0485*	0.0554*	0.0755*	0.2054*	1										
	0,000	0,000	0,001	0,446	0,000	0,000	0,000	0,000											
Company	0.3368*	0,004	0.1125*	0.1070*	-0,002	0.1421*	0.1063*	0.3383*	-0.0837*	1									
	0,000	0,640	0,000	0,000	0,791	0,000	0,000	0,000	0,000										
Partnership	-0.0314*	0,003	-0.0637*	-0,015	-0,001	-0.0457*	-0.0403*	-0.0812*	0.0980*	-0.4826*	1								
	0,000	0,742	0,000	0,086	0,949	0,000	0,000	0,000	0,000	0,000									
Other	-0,016	0.0547*	0,007	0.0357*	0.0612*	-0.0694*	0.0399*	0.0501*	0.1079*	-0.3151*	-0.0537*	1							
	0,066	0,000	0,441	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000								
Scotland	-0.0302*	-0.0268*	0,001	0,012	0.0450*	-0.0444*	-0,008	-0,008	-0,017	-0.0550*	0.0260*	0.0220*	1						
	0,001	0,002	0,879	0,181	0,000	0,000	0,358	0,359	0,056	0,000	0,003	0,011							
Wales	-0,001	0.0561*	0,000	-0,011	-0,009	-0.0268*	0.0211*	0,008	0,003	-0.0267*	0,002	0,014	-0.0732*	1					
	0,945	0,000	0,976	0,216	0,302	0,002	0,015	0,351	0,697	0,002	0,850	0,102	0,000						
Nothern Ireland	-0,002	-0.1255*	0,004	-0,011	0.0763*	0.0499*	0,013	-0,009	-0.0451*	-0.0345*	0,010	0,000	-0.0693*	-0.0439*	1				
	0,851	0,000	0,657	0,189	0,000	0,000	0,143	0,285	0,000	0,000	0,265	0,995	0,000	0,000					
Rural	-0.0580*	0,015	-0,015	-0,014	0,001	-0,015	-0.0593*	-0.0993*	0.0320*	-0.1105*	0.1113*	-0.0203*	0.0197*	0.0739*	0.0817*	1			
	0,000	0,091	0,076	0,105	0,868	0,090	0,000	0,000	0,000	0,000	0,000	0,019	0,023	0,000	0,000				
Production and construction	0.1026*	-0.0202*	-0.0335*	-0.0220*	0.0219*	0.0293*	-0.0653*	0.0304*	0.0876*	0,011	0.0384*	-0.0699*	0.0220*	0.0255*	0.0422*	0.1335*	1		
	0,000	0,020	0,000	0,011	0,012	0,001	0,000	0,001	0,000	0,218	0,000	0,000	0,011	0,003	0,000	0,000			
Transport, retail and food service	0.1299*	0,012	-0.0655*	-0.0618*	0,004	0.0253*	0.0402*	0.1047*	-0,001	-0.0357*	0.0671*	-0.0379*	0.0251*	0,009	0,016	0.0428*	-0.3256*	1	
	0,000	0,172	0,000	0,000	0,675	0,004	0,000	0,000	0,921	0,000	0,000	0,000	0,004	0,319	0,064	0,000	0,000		
Other services	-0.1156*	-0,010	0.0383*	0.0547*	0.1078*	-0.1438*	0.0964*	0.0505*	0.0419*	-0.1118*	-0.0612*	0.2191*	-0,015	0,014	-0,006	-0.0814*	-0.2383*	-0.2467*	1
	0,000	0,261	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,076	0,107	0,521	0,000	0,000	0,000	

Note: *Significant at the 5% level or better.

Table A3. Propensity score matching (T=1 when innovation reported during the Covid-19 pandemic).

Variable	Sample	Treated	Controls	Difference	% Difference	Std. Err.	T-stat.
			Full sample				
ln(Turnover)	Unmatched	12.928	12.755	0.172	1.352	0.038	4.48
	ATT	12.928	12.864	**0.063**	0.494	0.038	**1.66**

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