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Ambition, innovation and digital innovation in urban and rural micro-businesses

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Abstract

Here, using data on around 5,230 micro-businesses in England and Wales we examine the urban-rural profile of innovation and digital innovation along with a wide range of explanatory factors. After controlling for a wide range of factors related to business characteristics etc., first, we find, that rural micro-businesses are less likely to be innovating than similar firms in urban locations. Second, we find no difference between levels of digital innovation among rural and urban micro-businesses. Third, we find strong positive associations between micro-firms' business ambitions and both innovation and digital innovation. Fourth, we find a strong positive association between digital innovation and innovation related to products and processes. Together, our results suggest that levels of innovation reflect a combination of where firms are located and owner-managers' aspirations for growth or stability. Future work could usefully consider the determinants of ambition differences between urban and rural micro-firms and the source of residual differences in levels of innovative activity.

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Executive summary

Innovation is an interactive process driven by knowledge - technological, commercial and strategic. Firms' ability to access and utilise relevant knowledge is shaped by their own structural, organisational and managerial capabilities (Sternberg and Arndt, 2001) as well as the local environment in which they operate (Audretsch and Dohse, 2007). While the geography of innovation literature suggests that some external environments may be more conducive than others for undertaking innovation, the innovation literature asserts that firms' internal capabilities are amongst the most important drivers of innovation adoption. This includes factors such as owners-managers` motivation for becoming a business owner (Galloway and Mochrie, 2006) as well as their ambitions for sustainability and growth (Culkin and Smith, 2000; Morris et al., 2005)[1]. In this report we therefore address the central question: is it firms' location which is most important in shaping innovation, or is it their internal capabilities and aspirations? This question is perhaps clearest in micro-enterprises where internal resources are more limited, innovation depends critically on the owner-manager, and the local environment may be critical in providing enabling resources.

Our research considers the internal and external factors associated with innovation and digital innovation among rural and urban micro-businesses, with a particular focus on how owner-managers' business and personal ambition drive innovation. Accordingly, using the Micro-business Britain Survey (MBBS) data[2], which provides detailed information for 5,230 micro-businesses with 1-9 employees across England and Wales, this research examines the urban-rural profile of innovation and digital innovation along with a wide range of explanatory factors.

The results suggest some, perhaps unexpected, contrasts between innovation and digital innovation in urban and rural areas. The results emphasise the importance of micro-businesses' growth orientation or ambitions in shaping their innovation and digital innovation and the dominance of these factors relative to any urban-rural effect. Nonetheless, a significant urban-rural difference in the probability of innovation both in terms of new to firm and new to market product innovations and processes is observed, with rural micro-businesses less likely to be innovating than comparable firms in urban locations. As innovation has been strongly linked to firms' future growth and productivity these innovation differences suggest potential urban-rural disparities in future business performance, something which may be exacerbated by the effects of lower levels of growth ambition in rural areas.

This suggests two directions for future research. First, it seems important to understand what creates the observed differences in the ambition profiles of urban and rural firms. Are these simply a reflection of different patterns of ownership or sectoral structure or are other aspects of the business environment shaping firms' aspirations? Second, what factors lie behind the urban-rural differences in innovation that we identify even when we allow for a range of firm-level and locality indicators. In innovation surveys, for example, access to finance for innovation is often identified as a key barrier to innovation activity. Can this provide an explanation for urban-rural innovation differences or are these linked to other aspects of the local business environment?

1. Introduction

Innovation is an interactive process driven by knowledge - technological, commercial and strategic. Firms' ability to access and utilise relevant knowledge is shaped by their own structural, organisational and managerial capabilities (Sternberg and Arndt, 2001) as well as the local environment in which they operate (Audretsch and Dohse, 2007). Agglomeration advantages have often meant that urban centres have been considered as the main centres for innovation, while innovating in rural areas is often considered more challenging due to the lack of locally available specialized resources (Patterson and Anderson, 2003; Vaessen and Keeble, 1995), higher environmental and cultural barriers for knowledge creation and diffusion, poorer infrastructure for innovation, under-developed transaction markets for knowledge and information (Koo and Eesley, 2020), less generalised social trust for risk-taking, more short-term oriented behaviours and higher vulnerability to poverty (Blackmore, 2012; Fernández-Serrano et al., 2018; Long and Liu, 2016; Yin et al., 2019).

Not all innovation happens in and around cities, however. While business density and networking in urban areas may be conducive to innovative activity, innovation is still possible in a rural context, associated with innovators' individual choices, abilities and orientations (Bolton and Thompson, 2004; Galloway and Mochrie, 2006). Indeed, rural areas may provide unique challenges and market opportunities which businesses can collectively exploit as observed in rural UK, Scotland, Wales, Greece and Canada (Cosh and Hughes 1996, Galloway et al, 2004; Thomas et al, 2002; Baourakis et al, 2002 and NESTA, 2007). Many innovations in health, housing and transport have emerged primarily in response to growing demand in rural sectors such as the need to transport minerals, agricultural products or wood to ports or cities. For example, satellite generated geographic information systems, used by many urban motorists (Sat Nav), have their origins in rural Canada (NESTA, 2007).

The empirical literature suggests that rural SMEs do not necessarily under-perform in terms of innovation relative to those in urban areas (Jarvis et al., 2001; North and Smallbone, 1996; Patterson and Anderson, 2003; Smallbone and North, 1999a; Smallbone et al., 1999b; Westhead et al., 2004). Survey evidence from the 1990s for the UK suggested that rural firms were actually more likely to be innovating than firms in urban areas, and also more likely to introduce new to the market innovations (Cosh and Hughes 1996). Based on a study of UK firms, Keeble and Tyler (1995, p. 989) for example, concluded that: 'accessible rural firms are more dynamic, innovative and technologically focused than their counterparts in either urban or remote rural locations'. North and Smallbone (2000) suggest the importance of areas' sectoral mix in generating these results but also suggest that UK firms in accessible but rural areas were more likely to have adopted new technologies than those in more remote rural locations: 'In aggregate SMEs in remote rural areas are less innovative than SMEs in accessible rural areas because firms in the more innovative sectors are under-represented' (North and Smallbone 2000, p. 155). More recent survey evidence for England also points to higher levels of innovative activity in rural than urban areas but also highlights significant differences in innovation outcomes among SMEs between types of rural area (Phillipson et al. 2019). In their analysis of circa 12,000 SMEs in England they found in 2015 that similar percentages of rural and urban SMEs had introduced new or improved services and processes in the last three years, and that rural firms were more likely to have introduced

new or improved goods during this period. At an aggregate level similar proportions of urban and rural firms had engaged in new to the market innovation, however, there was evidence that SMEs in the most rural districts faced 'greater difficulties in realising the commercial development of 'breakthrough' innovations' (p. 237).

Accordingly, while the geography of innovation literature suggests that some external environments may be more conducive than others for undertaking innovation, the innovation literature asserts that firms' internal capabilities are amongst the most important drivers of innovation adoption. This includes factors such as owner-managers' motivation for becoming a business owner (Galloway and Mochrie, 2006) as well as their ambitions for sustainability and growth (Culkin and Smith, 2000; Morris et al., 2005)[3]. In this report we therefore address the central question: is it firms' location which is most important in shaping innovation, or is it their internal capabilities and aspirations? This question is perhaps clearest in micro-enterprises where internal resources are more limited, innovation depends critically on the owner-manager, and the local environment may be critical in providing enabling resources. On the other hand, smaller firms are often said to have advantages in terms of rapid decision-making, willingness to take risks and flexibility in responding to new market opportunities (Vossen, 1998).

Here, we consider the internal and external factors associated with innovation and digital innovation among rural and urban micro-businesses, with a particular focus on how owner-managers' business and personal ambition drive innovation. Our empirical analysis is based on the Micro-business Britain Survey (MBBS) which provides detailed information for 5,230 micro-businesses with 1-9 employees across England and Wales. The MBBS provides data on product, process and digital innovations as well as indicators of personal and business ambition and business performance. The MBBS`s definitions of product and process innovation are in line with the OECD`s OSLO manual. Accordingly, product innovation is defined as the introduction of new or significantly improved products or services and process innovation is defined as the introduction of new or significantly improved forms of organisation, business structures or processes. The survey also adds a novelty component in questions related to product innovation and further identifies whether the product innovation was new to the firm or new to the market.

Business ambitions identified in the MBBS include: 1) to build a national and/or international business, 2) to keep my business similar to how it operates now, 3) to grow my business rapidly and profitably with a view to exit, 4) to develop more professional HR practices in the business, 5) to create a culture of employee engagement and 6) to increase the social and environmental benefits of the business. Owner-managers' personal ambitions include 1) to have greater flexibility for my personal and family life, 2) to have considerable freedom to adapt my own approach to work, 3) to have a chance to build great wealth or a very high income, 4) to fulfil a personal vision of becoming a successful business leader in my community, 5) to build a business to hand on to my family and 6) to be able to retire. We matched the MBBS with the UK postcode directory to identify businesses in urban and rural areas.

Our analysis suggests some, perhaps unexpected, contrasts between innovation and digital innovation in urban and rural areas. First, allowing for a wide range of firm characteristics and owners`-managers' ambition, our results suggest that urban micro-businesses are more likely to undertake new to firm product innovation, new-to-market product innovation and process innovation. Second, in terms of digital innovation,

however, we find no significant difference between urban and rural micro-businesses. Third, rather different attitudinal factors are related to innovation and digital innovation: aspects of business ambition are strongly related to new to firm product innovation, new-to-market product innovation and process innovation; business owners' personal ambitions prove significantly more important for digital innovation.

The rest of the paper is organised as follows. Section 2 briefly reviews some earlier literature on the relationship between ambition and innovation. Section 3 describes our data on micro-businesses in England and Wales and our approach to classifying firms as 'urban' and 'rural'. Section 4 outlines the main empirical results and Section 5 includes discussion and conclusions.

2. From ambition to innovation

The returns to investing in any particular novel product, process or organisational method will depend on the maturity of the innovation and may involve considerable uncertainty comprising both technical and commercial risks (Astebro and Michela 2005). Technical uncertainty or risks may arise due to difficulties associated with implementing new products or technologies, adapting to new processes or issues of organisational incompatibility. Commercial risks may relate to implementation costs or related service failure (e.g. Liao et al. 2015). Firms with stronger growth ambitions may have an aspiration for higher returns over the planning horizon and, potentially, a greater tolerance of downside returns or risk. Lower levels of growth ambition may equate to a desire for a less extreme payoff profile which minimises downside risk and provides more predictable, if lower, returns. This may lead to different patterns of innovative behaviour with more ambitious firms more willing to accept the associated technical and commercial risks associated with innovations (LaRose et al., 2007).

In the case of small firms, which are often ``personality driven'' in a way that larger organisations are not, the owners-managers` context, attitudes and behaviour is crucially important for understanding how they operate and make decisions (Culkin and Smith, 2000). In line with this, Defra`s report on opportunities and barriers to business innovation in rural areas (Defra, 2010) found that `in a rural setting, personal attitude and outlook of entrepreneurs (in particular, motivation, confidence and a willingness to embrace new technologies and ideas) are key factors in overcoming barriers to innovation by some businesses`. However, not all businesses are able to innovate and as stated by Mitchell and Clark (1999 p. 454) particularly in rural areas owner/managers may not always be able to link investment in innovation with business success, which could explain low adoption of ICTs amongst rural businesses. Nevertheless, based on an econometric analysis of 872 entrepreneurial firms in Norway, Rypestøl and Aarstad (2018) found that entrepreneurs located in urban areas are more innovative[4] than rural ones but found no significant differences in entrepreneurs' growth ambitions. For SMEs in the USA, Vonortas and Xue (1997) observed that internal resources, and the technical and organisational competencies that a firm has developed or accumulated over time were amongst the main drivers of process innovation. Supporting this argument, Galloway and Mochrie (2006) suggested that distance and remoteness are not the only explanatory factors in explaining the differences in adoption and diffusion of new technologies within rural areas. Their work emphasises not only the importance of differences in geographical context but also shows that differences in industries and sectors, a firm`s internal capabilities, the

owner-managers` growth ambition, and the specificity of the technology are also crucial in explaining the unequal adoption of technologies (see also Labrianidis and Kalogeressis, 2006; Jarvis et al., 2006; Galliano et al., 2001; Galliano and Roux, 2008).

Previous studies also suggest that early adopters of new technologies have usually had previous experience with ICTs or broadband (Hollifield and Donnermeyer, 2003; Youtie et al., 2007; LaRose et al., 2007), and that firms with a track record of investment in new technology (Roper and Hewitt-Dundas, 2015) may place more value on digital adoption. A firm`s previous experience in combining existing knowledge and the newly acquired knowledge is an important component of transformation of knowledge and hence, its absorptive capacity (Cohen and Levinthal, 1990; Zahra and George, 2002). Firms could develop necessary skills and flexibility required to accommodate new technologies, procedures, routines and working practices within the firm through past experiences. This is particularly important in cases where a digital technology is complementary to firms' existing technologies, which may increase the perceived value of the technology and hence, its adoption (Colombo et al., 2006; Cassiman and Veugelers, 2006). These conceptual arguments imply that SMEs with greater absorptive capacity may assess the returns to adoption more positively than those with weaker capabilities (Ahlin et al., 2014), and that firms with experience in adopting innovations are prone to adopt other complementary digital technologies, processes and products. Therefore, even where the expected returns from adoption are similar, ambitious firms may make different adoption decisions to those with more of a focus on stability or sustainability. Ceteris paribus, this suggests that more ambitious firms are more likely to adopt any given technology and also that they are more likely to be early adopters of emerging technologies such as artificial intelligence or machine learning[5].

3. Data and methods

3.1. Data sources

Our analysis is based on the Micro-business Britain Survey (MBBS), which was conducted in 2018 with individuals who were either the owner or manager of each business. The focus was on established micro-businesses across the UK nations, i.e. firms with 1-9 employees that had been established for three years or more. Firms were excluded from the survey if they were branches, divisions or subsidiaries of larger companies, if they were charities, or if they were part of the public sector. Firms in the 5-9 size-band were over-sampled as were firms in some UK regions (Northern Ireland and Wales) to prevent particularly small sample sizes in these group (please see annex for more detail)[6]. In the analysis responses are therefore weighted to obtain representative results[7]. The UK Micro-business Survey included 6,254 micro-businesses in England, Wales, Scotland and Northern Ireland. However, we could use only a subset of the whole sample comprising 5,230 micro-businesses in England and Wales as the Scotland and Northern Ireland sample lacked the urban-rural identifier. The survey was undertaken by telephone using a CATI system between February and May 2018 based on a commercially-sourced sampling frame and achieved a response rate of 9.3 per cent. The survey asked about a number of key business characteristics and strategies, provides a detailed overview of the structure and bio-demographics of the leadership team, information on the ambition of the respondent and business, and detailed information on the adoption of product, process and digital innovations.

We extend the set of firm-level variables available in the MBBS by matching with several indicators using respondents' postcode. The Postcode Directory provides information for each UK postcode on variables such as urban-rural status and categorisation (see below) and the Index of Multiple Deprivation (IMD). The IMD provides an indication of the degree of deprivation in any local area including issues such as the labour market, skills, housing, infrastructure and the environment[8].

3.2. Identifying urban and rural areas in the Micro-business Survey

Internationally, and throughout the research literature, rurality has been defined in a range of different ways. Population density, or more accurately sparsity, has often been used to characterise and define 'rural' areas. OECD (1996), for example, classified areas (local administrative units) as rural if they had a population density below 150 people per km square[9] [10]. Dijkstra and Poelman (2010) defined a new rurality typology based on population density but based on a population grid rather than local administrative units. In their analysis, urban areas (1km grid squares) are defined as meeting: (1) a population density threshold (300 inhabitants per km^2) and (2) a minimum size threshold (5000 inhabitants) applied to grouped grid cells above the density threshold. Rural grid squares are those outside these urban areas[11]. As with the OECD (2006) typology, regions are then defined as predominantly rural if more than 50 per cent of the population live in 'rural' grid squares[12]. As Dijkstra and Poelman (2008) suggest, this type of one-dimensional approach to categorising geographies has the advantage of simplicity but does not capture accessibility or the proximity of any area to local cities or population centres (Fertner, 2012).

This combination of local density and proximity is, however, reflected in the urban-rural classification used in England and Wales, which uses population density in the immediate and surrounding areas to generate a two-dimensional classification. First, census output areas which fall into settlements with populations of more than 10,000 are classed as urban. Urban output areas are then grouped into those in three settlement types: major conurbations; minor conurbations; or, city and town. Rural output areas are also grouped using population density into three settlement types: town and fringe; village; or, hamlet and isolated dwelling. A second dimension to the typology – also based on population density – relates to the sparsity of population in surrounding areas[13]. Each of the three types of rural areas (as well as 'city and town') are then classified as in a 'sparse setting' or 'not sparse'.

The Micro-business Britain Survey was not originally designed to provide coverage separately for urban and rural firms provides a good overall coverage of micro-businesses across the UK. In total, 32.5 per cent of respondents to the MBBS were in rural areas compared to 33 per cent of all English registered businesses being classified as rural in the Inter-Departmental Business Register (DEFRA, 2016). The number of respondents in some types of rural areas is small, however, and so in the empirical analysis we adopt a simple binary indicator to identify firms that are located in urban or rural areas. This binary measure takes value of 1 if a business is located in any of the urban areas e.g. sub-categories 1 to 4, and 0 if a business is located in any of the rural areas e.g. sub-categories 5 to 10 (Annex 1).

3.3. Empirical approach

Following previous studies, we estimate a Logistic model to estimate the probability that a firm engaged in i) new to firm product innovation, ii) new to market product innovation, iii) process innovation and iv) any type of product innovation in the last three years (Karshenas and Stoneman, 1993; Bourke and Roper, 2014). If A_i is the probability of engaging in any of the four innovation output variables then:

$$A_i = \beta_0 + \beta_1 CONT_i + \beta_2 Urban\_vs\_Rural_i + \beta_3 IMD_i + \beta_4 Business\_A_i + \beta_5 Personal\_A_i + \beta_6 Digital_i + \beta_7 Industry_i + \beta_8 Regional_i + \varepsilon_i \quad (1)$$

Where: β_1 is the coefficient that captures the effects for a vector of control variables (CONT), β_2 is the coefficient designed to capture the effects of urban vs rural dummy (Urban_vs_Rural), β_3 is the coefficients that capture specific local disadvantages (IMD), β_4 is the coefficient for a vector of variables designed to capture the owners`/managers` business ambition (Business_A), β_5 is the coefficient for a vector of variables designed to capture the owners`/managers` personal ambition (Personal_A), β_6 is the coefficient that captures the effect of digital innovation adoption (Digital), β_7 and β_8 capture sectoral and regional specific differences, respectively, and ε_i is the error term.

We estimate a similar adoption function using a Logistic model for the probability that a firm adopted i) digital innovation, ii) established digital innovation and iii) emerging digital innovation. Accordingly, if A_i is the probability of adopting one of the above digital innovation output variables then:

$$A_i = \beta_0 + \beta_1 CONT_i + \beta_2 Urban\_vs\_Rural_i + \beta_3 IMD_i + \beta_4 Business\_A_i + \beta_5 Personal\_A_i + \beta_6 Product\_innovation_i + \beta_7 Process\_innovation_i + \beta_8 Indsutry_i + \beta_9 Regional_i + \varepsilon_i \quad (2)$$

Where: β_1 is the coefficient that captures the effects for a vector of control variables, β_2 is the coefficient designed to capture the effects of urban vs rural dummy, β_3 is the coefficients that capture specific local disadvantages, β_4 is the coefficient for a vector of variables designed to capture the owners`/managers` business ambition, β_5 is the coefficient for a vector of variables designed to capture the owners`/managers` personal ambition, β_6 and β_7 are the coefficients that captures the effect of product (new to firm and/or new to market) and process innovation adoption, respectively. β_8 and β_9 capture the sectoral and regional specific differences, respectively, and ε_i is the error term.

3.3.1. Dependent variables

Innovation performance can be measured based on R&D spending, patents and the introduction of new products, services or processes (Zhang et al., 2014). Here, we measure innovation performance by using seven dependent variables which reflect different aspects of firms' innovation and digital innovation activity:

- *New to Firm Product Innovation* refers to the introduction of new or significantly improved products or services and the binary indicator takes the value of 1 if a firm introduced a product innovation between 2015-2018.
- *New to Market Product Innovation* identifies new products and services introduced to the market before competitors. This binary variable takes the value of 1 if a firm

introduced a product innovation that is new to the market between 2015-2018 and 0 otherwise.

- *Process Innovation* refers to any new or significantly improved forms of organisation, business structures or processes. This binary indicator takes the value of 1 if a firm introduced a process innovation between 2015-2018.
- *Innovation* takes the value of 1 if a firm introduced either new to firm product innovation or process innovation between 2015-2018, and 0 otherwise.

The survey also asked firms about the adoption of six general-purpose digital technologies. Three of these were 'established' technologies: Customer Relationship Management systems (CRM), E-commerce and Web-based accounting software. CRM systems use data analysis about customers' history to improve business relationships with customers, specifically focusing on customer retention. E-commerce involves selling goods and/or services through the company website. Web-based accounting software is an accounting information system which can be accessed with any device which is internet enabled. Three other technologies – Cloud Based Computing, Artificial Intelligence and Machine Learning Technologies- fall into the more 'emergent' category with much lower levels of current adoption. Cloud based computing involves the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer. AI involves the simulation of human intelligence processes – learning, reasoning and self-correction - by machines, especially computer systems. ML use statistical techniques to give computers the ability to "learn" (i.e., progressively improve performance on a specific task) with data, without being explicitly programmed.

For each technology firms were asked whether they use each of these technologies using a binary indicator. Accordingly, we construct three dependent variables:

- Digital Innovation is a binary indicator and identifies firms that adopted at least one of the six digital technologies between 2015-2018[14].
- Established Digital Technologies is a binary indicator and identifies firms that adopted at least one of three established digital technologies between 2015-2018.
- Emergent Digital Technologies is a binary indicator and identifies firms that adopted at least one of three emerging digital technologies between 2015-2018.

Around 34 per cent of micro-businesses introduced new to firm product innovations and about 12 per cent of introduced new to market product innovations (Table 1). We also observe that about 25 per cent of the micro-businesses introduced new process innovations and about 47 per cent engaged in some form of innovative activity (Table 1). About 73 per cent of the micro-businesses in England and Wales adopted at least one of 6 digital innovations whereas about 62 and 58 percent adopted established and emerging digital innovation, respectively.

3.3.2. Independent variables

3.3.2.1. Business and Personal ambition

The Micro-business Britain Survey identified six business and six personal ambitions, and owners-managers were asked to indicate the importance of each using a 5-point Likert scale ranging from "not at all important = 1" to "very important = 5". For the empirical analysis we transform the Likert scale into a binary variable for each of these ambitions, which take the value 1 if a business identified this objective as 'fairly important' or 'very important'.

Overall, 24 per cent of 'ambitious' UK micro-businesses suggested that 'building a national or international business was either fairly important or very important', whereas 73 per cent of these businesses suggested that 'keeping my business similar to how it operates' was either fairly important or very important (Table 1). Amongst the personal ambitions, 'having greater flexibility' and 'having considerable freedom' was either fairly important or very important' for 81 per cent of the business owners/managers, respectively. We also observe that 64 per cent of the businesses owners/managers suggested that 'being able to retire' was either fairly important or very important' (Table 1).

3.3.3. Control variables

We include a number of control variables in our analysis. Involvement of the original founder, being home-based and family-owned has been shown to be negatively related to innovation (Willard et al., 1992). Hence, we included three binary variables in our empirical model to control their effect on innovation behaviour. Previous studies show that the size of the business may have a significant impact on innovation behaviour (Mazzarol et al., 2010). Accordingly, we included firm size, measured by the number of employees, to control for firm size effect. A business owner-manager`s previous experience in managing and/or owning any other business may have positive impact on innovation behaviour. Therefore, a binary variable, which take the value 1 if the owner/manager has ever managed or owned any other business, is also included in the model. Previous studies have also linked training (Borras and Edquist, 2015; Conte and Vivarelli, 2014) and exporting (Love and Roper, 2015) to innovation and business performance. To reflect firms' organisational and managerial capabilities, we include a dummy variable for whether or not a firm invests in providing on or off-site training for employees or business managers. To reflect firms' market profile, we include a dummy variable which indicates whether a firm is exporting. Previous studies have suggested that networks may matter differently for varying types of innovation (Kim and Lui, 2015). Hence, we also included a binary variable indicating whether the business is a member of formal business organisations or networks[15]. We also included 10 regional dummy variables for i) East of England, ii) East Midlands, iii) London, iv) North East, v) North West, vi) South East, vii) South West, viii) West Midlands, ix) Yorkshire & Humberside, x) Wales to pick up any broader regional influences. Similarly, we also included 9 aggregated industry dummies to pick up broader sectoral influences. The dummies include i) Primary, ii) Manufacturing, iii) Construction, iv) Retail & Wholesale, v) Transport, Accommodation & Food, vi) Information, Finance & Real Estate, vii) Professional & Scientific, viii) Administrative services, ix) Other services.

We also use control variables derived from the English Index of Multiple Deprivation (IMD) 2015 to reflect specific local disadvantages (Smith et al. 2015). The IMD variable is a categorical variable created using the quartiles of the IMD distribution. Accordingly, the lower-end of the quartile (first quartile) represents the UK micro-businesses located in less deprived areas whereas the high-end of the quartile (fourth quartile) represents the UK micro-businesses located in more deprived areas.

On average, 59 per cent of the UK micro-businesses were managed by the founder, 56.5 per cent were home-based and 69 per cent were family-owned (Table 1). The businesses have, on average, 4 employees and 40 per cent of the owners/managers have owned or managed other businesses in the past. We also observe that 32 per cent of UK micro-businesses are exporting, 71 per cent provide training for their employees or business managers and 42 per cent are part of a network (Table 1).

4. Empirical analysis

4.1. Comparing the characteristics of urban and rural businesses

Before our econometric analysis we first compare the characteristics of urban and rural businesses. This preliminary analysis is important as it helps us to identify the structural differences between urban and rural firms. For ease of presentation in table 2, the cells showing statistically significant differences between urban and rural firms are coloured. For example, if a cell is coloured orange, the difference in means between rural and urban firms is statistically significant and in favour of urban firms. If a cell is coloured green, then the difference in means is statistically significant and in favour of rural firms, and if left unfilled it means that the difference in means between urban and rural firms was not significant.

The results show that there is a statistically significant difference in means between the urban and rural firms regarding innovation performance (Table 2). Urban businesses, on average, are significantly more likely to engage in each type of innovation than the rural firms (Table 2). We also observe that urban and rural firms are rather similar in regard to their structural characteristics, but there are a few significant differences between them. For example, 48 per cent of micro-businesses are home-based in rural areas whereas about 60 percentage points of the businesses are home-based in the urban areas. In addition, 78 per cent and 65 per cent of businesses are family owned in the rural and urban areas, respectively. Urban and rural businesses also differ in relation to their networking, 44.5 per cent of the rural and 41 per cent of the urban firms are part of a wider network (Table 2).

The t-test results also suggest that urban and rural businesses differ with respect to their business and personal ambitions. Regarding business ambitions: 21 per cent of rural firms and 25.5 urban firms intend to `build a national and/or international business`. In addition, about 27 per cent of rural businesses and 34 per cent of urban businesses intend to `grow their business rapidly`. 21 per cent of rural businesses and 25.5 per cent of urban businesses intend to `develop more professional HR practices`, and 52 per cent of rural businesses and 58 per cent of urban businesses intend to `create a culture of employee engagement` (Table 2). Regarding personal ambitions; we observe that 79 per cent of the rural firms and 81 percent of urban firms intend to `to have considerable freedom to adapt

their own approach to work`. 39 per cent of rural businesses and 43 per cent of urban businesses intend to `have a chance to build great wealth or a very high income`. 42 per cent of rural businesses and 46 per cent of urban businesses intend to `fulfil a personal vision of becoming a successful business leader'. And, 46 per cent of rural businesses and 41 per cent of urban businesses intend to `build a business to hand on to their family`.

Bivariate comparisons of innovation and digital adoption between urban and rural firms will reflect both these structural differences in firm characteristics as well as the potential impact of firms' urban or rural location. In the next section we therefore estimate multi-variate models which allow us to control for the influence of these differences in firm characteristics and ambition to more accurately identify the impact of locational factors on micro-businesses' innovation activity.

4.2. Regression results

Logistic regression model estimates reflecting the probability to engage in new to firm product innovation, new to market product innovation, process innovation, and any form of innovation. The marginal effects of the coefficients pertaining Logistic model are presented in Table 3.

The results suggest that even controlling for a wide range of firm characteristics and levels of ambition there remains a significant difference between the probability of undertaking innovation in urban and rural micro-businesses. Specifically, controlling for other factors, micro-businesses in urban areas are 2.3 – 3.5 percentage points more likely to engage in all four types of innovation compared to businesses in rural areas (Table 3). This result is at odds with other studies which have suggested that firms in rural areas are actually more likely to be innovating than their urban counterparts (e.g. North and Smallbone, 2000; Phillipson et al. 2019). Two factors may be important in explaining this divergence. First, the current study focuses on micro-businesses which may be particularly dependent on resource availability in the local business environment, something which may be more challenging in a rural environment (Patterson and Anderson, 2003; Vaessen and Keeble, 1995). Second, here we are able to control for a wider variety of personal and business characteristics and aspirations than in most other studies which may be helping to avoid a mis-attribution of any locational effects due to differences in firm characteristics between urban and rural firms (Table 2).

Aspects of business ambition are also strongly associated with the probability of innovation. Firms with an aspiration to build a national and/or international business were 6-12 percentage points more likely to be innovating than firms without this aspiration. On the contrary firms with an aspiration for stability – 'keep my business similar to how it operates now' – were 5.2-12.2 percentage points less likely to be innovating (Table 3). A desire for rapid growth and also creating a culture of employee engagement were also positively and significantly associated with innovation. Comparing the size of the coefficients relating to urban-rural location and aspects of business ambition provides an indication of the relative importance of the two factors in shaping the probability of innovating. Coefficients on the location of the firm are consistently smaller, suggesting aspects of business ambition are more strongly associated (by a factor of 3-4) with the probability of innovation. Notably only two aspects of personal ambition i) 'to have a chance to build great wealth` and ii) `to build a business to hand on to my family` are

significantly associated the probability of innovating. Albeit a weak significance at 10% level, the former indicates that managers aiming to build great wealth are 3 percentage point less likely to invest in innovation, whereas the latter indicates that managers aiming to build a business to hand on to their families are 2.7 percentage point more likely to invest in innovation.

Other firm level control variables have expected associations with the probability of innovating, although our results relating to the index of multiple deprivation variables prove statistically insignificant. Having the founder still involved in the business is positively associated with the probability of new to firm product innovation, new to market product innovation and innovation (2.7 – 6.1 percentage points). We find no significant differences in terms of the likelihood to be undertaking process innovation between micro-businesses managed by their founders and those managed by a non-founding manager. Our results also point to a strong positive link between managers' previous experience in managing another business in the past and innovation (3.9 -9.7 percentage points). This result is statistically significant for all of the innovation indicators (Table 3). As anticipated a strong positive link is also evident between exporting and product related innovation (6.0-8.2 percentage points). There is no significant link between exporting and process change, reflecting the findings of other recent studies which suggest that the exporting decision is more strongly associated with product rather than process change (Gkypali et al. 2021). Training and networking are also positively linked to the probability of innovation (Table 3).

It is worth noting that we identify a strong positive association between digital adoption and the four innovation output indicators, i.e. firms undertaking digital adoption were on average 5.8-10.6 percentage points more likely to be undertaking new to firm product innovation, new to market product innovation, process innovation, and any innovation. This emphasises the role of digital technologies as an enabler of innovation, a factor that may be particularly important in smaller firms. The positive association with both product and process innovation may also reflect the different roles which digital technologies can play in the innovation process supporting the creation of digitally enabled products and/or acting as an enabler of more effective and efficient innovation processes (Nambisan, 2017). For example, Karakaya and Shea (2008) indicate that firms that adopt e-commerce are able to boost their long-term competitiveness by sustaining the reputation of their firm and responding more effectively to their customers' needs. Similarly, the evidence suggests that the adoption of AI increases the efficiency of analysing information and allows firms to make faster and more precise decisions leading to cost savings (Plastino and Purdy, 2018).

Finally, we observe that industry specific dummies provide some anecdotal evidence[16]. Precisely, the results indicate that micro-businesses in `manufacturing industries` are 8.3 and 5.5 percentage points more likely to adopt new to firm and new to market product innovations, respectively. Businesses in Retail & Wholesale (8.4 percentage points) and Other services (13.3 percentage points) are more likely to adopt new to firm product innovations whereas, businesses in Transport, Accommodation & Food industry (7.4 percentage points) are less likely to adopt process innovation.

Next, we look at our findings in relation to the probability of adopting digital innovations. The marginal effects of the coefficients are presented in table 4.

In table 2, the t-test results showed that there are notable differences in means between rural and urban firms with respect to some key characteristics, and that on average urban firms are more likely to adopt digital technologies compared to rural firms. However, after controlling for other firm specific characteristics and capabilities, perhaps surprisingly, we observe no statistically significant difference between urban and rural micro-businesses. In other words, the difference in likelihood of adopting digital technologies, including established and emergent digital technologies, between urban and rural businesses disappears once we compare comparable businesses. The results presented in table 4 indicate that rural micro-businesses appear no more or less likely to adopt digital technologies than urban firms. This result contrasts with the results of a number of previous studies which have suggested the potential impact of issues such as broadband availability on a potential 'digital divide' between urban and rural areas (Prieger, 2013; Herdon et al., 2015; Philip et al., 2015; Erdiaw-Kwasie and Alam, 2016; Romo, 2016; Richmond et al., 2017).

We also observe a profile of links between aspects of business and personal ambition and digital innovation which differs somewhat to that for product and process innovation. Here, we again see a positive association between the desire to 'build a national or international business' (6.4 -7.0 percentage points) and digital innovation and between the aspiration to 'create a culture of employee engagement' and digital innovation (4.0-4.9 percentage points). Firms aiming more at stability were less likely to be digital innovators. Unlike product and process innovation, however, aspects of personal ambition also play a role in shaping digital innovation. Specifically, business managers aiming to `have greater flexibility`, `considerable freedom`, 'build great wealth' and ` fulfil a personal vision of becoming a successful business leader ` are significantly more likely to undertake digital innovation (Table 4).

As before other controls prove predictable, although again we find few consistent results with the IMD (Table 4). Micro-businesses managed by their founders, home based businesses, current employment, prior experience, training and exporting are all consistently and positively associated with digital innovation, reflecting our earlier results for product and process innovation (Table 4).

Finally, it is important to note that industry specific dummies provide some important evidence in support of the significance of industry specific differences in driving the adoption of digital innovations. Precisely, the results indicate that micro-businesses in `Manufacturing industries`, `Construction`, `Information, Finance & Real estate`, `Professional & Scientific` and `Administrative services` are more likely to adopt all types of digital technologies. We also observe that businesses in `Retail & Wholesale` are more likely to adopt digital and established digital innovations, but not emerging digital innovations.

5. Conclusion

Our analysis of urban-rural differences in innovation and digital innovation among micro-businesses in England and Wales suggests four main conclusions. First, controlling for a wide range of factors related to business characteristics and aspiration, we find that rural micro-businesses are 2.3-3.0 percentage points less likely to be innovating than similar firms in urban locations. This contrasts with some earlier UK studies – albeit based on

different groups of firms – which have suggested that rural firms may actually be more innovative than urban firms, particularly where those rural firms are located on the fringes of urban areas (Cosh and Hughes, 1996; North and Smallbone, 2000; Phillipson et al. 2019). This difference in results may be attributable to the specific focus of our study on micro-businesses or due to methodological issues related to the range of control variables used in different studies[17].

Second, and again controlling for a wide range of factors related to business characteristics etc., we find *no* difference between levels of digital innovation among rural and urban micro-businesses. This result is consistent both for more established digital technologies and those which are more emergent (cloud-based computing, AI etc.). Here, our findings contrast with earlier suggestions of a digital divide between urban and rural areas in terms of digital adoption (Prieger, 2013; Herdon et al., 2015; Philip et al., 2015; Erdiaw-Kwasie and Alam, 2016; Romo, 2016; Richmond et al., 2017), although again issues such as broadband availability which may influence digital adoption in rural areas may be confined to specific rural areas with poorer broadband provision.

Thirdly, we find strong positive associations between firms' business ambitions and both innovation and digital innovation – the more ambitious the micro-business the higher the likelihood of innovating. For example, innovation was 5.9-11.9 percentage points more likely among micro-businesses which had the aspiration to create a national or international business. Digital innovation was 6.4-7.0 percentage points more likely among the same group of firms. In each case the size of these ambition effects is significantly larger than the effect of any locational influence. This suggests that it is not so much where firms are located which matters for innovation and digital innovation. More important are the aspirations of owner-managers in terms of growth or stability.

The relationship between innovation, location and ambition is complicated further by the fact that we see significant differences in levels of ambition and other characteristics between urban and rural firms. Business ambitions for growth are stronger in urban areas, as are personal ambitions linked to wealth creation. Rural firms are significantly more likely to seek to 'build a business to hand on to my family' reflecting higher levels of family ownership among rural micro-businesses (Table 2). The strong link we observe between ambition and innovation suggests both that for similar firms, innovation will be higher in urban areas, and that not allowing for differences in ambition between urban and rural firms in studies of innovation differences may lead to misleading results.

Fourth, we find a strong positive association between digital innovation and innovation related to products and processes. This suggests the enabling role of digital innovation in supporting the development of products/services which are digitally enabled and potentially increasing the efficiency of firms' innovation processes (Nambisan, 2017; Plastino and Purdy, 2018). The scale of these enabling effects of digital innovation on product and service innovation are sizable and comparable to those of growth ambition (5.8-10.0 percentage points) (Table 4).

Our findings emphasise the importance of micro-businesses' growth orientation or ambitions in shaping their innovation and digital innovation and the dominance of these factors relative to any urban-rural effect. Nonetheless we do observe a significant urban-rural difference in the probability of innovation both in terms of products, processes and new to market innovation. As innovation has been strongly linked to firms' future growth

and productivity these innovation differences suggest potential urban-rural disparities in future business performance, something which may be exacerbated by the growth effects of lower levels of growth ambition in rural areas (Levie and Vanino, 2017). This suggests two directions for future research. First, it seems important to understand what creates the observed differences in the ambition profiles of urban and rural firms. Are these simply a reflection of different patterns of ownership or sectoral structure or are other aspects of the business environment shaping firms' aspirations? Second, what factors lie behind the urban-rural differences in innovation that we identify even when we allow for a range of firm-level and locality indicators. In innovation surveys, for example, access to finance for innovation is often identified as a key barrier to innovation activity. Can this provide an explanation for urban-rural innovation differences or are these linked to other aspects of the local business environment?

Finally, it is worth noting the limitations of our current analysis. First, we are using cross-sectional data and so findings suggest correlation rather than causation. Future analysis based on longitudinal sources such as the Longitudinal Small Business Survey might provide more causal results. Second, our data relates to 2018, prior to the COVID-19 pandemic which has significantly altered firms' digital adoption behaviour. Repeating the analysis on more recent data seems important before strong policy implications could be drawn. Finally, the type of econometric analysis reported here often raises more questions than answers. Complementing this by qualitative analysis of the determinants of rural and urban ambition would be a useful next step.

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Tables

Table 1: Descriptive statistics for all Micro-business Britain survey respondent					
	Obs.	Percentage	Std. Dev.	Min	Max
Dependent Variables					
1) New to Firm Product Innovation	5,170	34.4%	0.475	0	1
2) New to Market Product Innovation	5,093	12%	0.325	0	1
3) Process Innovation	5,160	24.9%	0.433	0	1
4) Innovation	5,161	47.1%	0.499	0	1
5) Digital Innovation	5,232	72.8%	0.445	0	1
6) Established Digital Innovation	5,232	62.5%	0.484	0	1
7) Emerging Digital Innovation	5,232	58.2%	0.493	0	1
Spatial and resource indicators					
8) Urban vs Rural	5,230	68.5%	0.464	0	1
9) IMD	5,231	2.5	1.118	1	4
Business Ambition					
10) to build a national and/or international business	5,180	24.1%	0.428	0	1
11) to keep my business similar to how it operates	5,189	72.7%	0.445	0	1
12) to grow my business rapidly	5,134	31.7%	0.465	0	1
13) to develop more professional HR practices	5,148	24.1%	0.428	0	1
14) to create a culture of employee engagement	5,124	55.8%	0.497	0	1
15) to increase the social and environmental benefits of the business	5,131	48.6%	0.5	0	1
Personal Ambition					
16) to have greater flexibility	5,087	81.4%	0.389	0	1
17) to have considerable freedom	5,085	80.7%	0.394	0	1
18) to have a chance to build great wealth	5,084	42%	0.494	0	1
19) to fulfil a personal vision of becoming a successful business leader	5,087	44.6%	0.497	0	1
20) to build a business to hand on to my family	5,048	42.4%	0.494	0	1
21) to be able to retire	5,080	63.6%	0.481	0	1
Controls					
22) Founder	5,232	58.7%	0.492	0	1
23) Home Based	5,216	56.5%	0.496	0	1
24) Family Owned	5,225	68.8%	0.463	0	1
25) #Current Employment	5,232	3.955	2.224	1	9
26) Previous Experience	5,172	40.1%	0.49	0	1
27) Exporting	5,021	32.3%	0.468	0	1
28) Training	5,202	71.2%	0.453	0	1
29) Networking	5,146	42.1%	0.494	0	1

Table 2: Descriptive statistics and t-test of different means for rural and urban businesses					
	Rural		Urban		Difference in means
Dependent Variables	N	Percentage	N	Percentage	Pr(|T| > |t|)
1. New to Firm Product Innovation	1,631	31.55%	3,537	35.8%	0.003**
2. New to Market Product Innovation	1,612	10.4%	3,479	12.8%	0.017**
3. Process Innovation	1,625	22.2%	3,533	26.2%	0.002**
4. Innovation	1,630	43.4%	3,529	48.9%	0.000***
5. Digital Innovation	1,646	70.6%	3,584	73.8%	0.000***
6. Established Digital Innovation	1,646	60.9%	3,584	63.3%	0.0996
7. Emerging Digital Innovation`	1,646	54.6%	3,584	59.9%	0.000***
8. IMD	1,646	2.76	3,584	2.38	0.000***
Controls					
9. Founder	1,646	60.2%	3,584	57.8%	0.105
10. Home Based	1,646	47.8%	3,572	60.3%	0.000***
11. Family Owned	1,646	77.6%	3,577	64.8%	0.000***
12. #Current Employment	1,646	3.92	3,584	3.97	0.426
13. Previous Experience	1,633	41.3%	3,537	39.5%	0.202
14. Exporting	1,585	31.2%	3,434	32.7%	0.292
15. Training	1,641	71.3%	3,559	71.1%	0.873
16. Networking	1,624	44.5%	3,520	40.9%	0.015**
Business Ambition					
17. To build a national and/or international business	1,628	21.1%	3,550	25.5%	0.000***
18. To keep my business similar to how it operates	1,631	72.7%	3,556	72.8%	0.979
19. To grow my business rapidly	1,613	27.3%	3,519	33.6%	0.000***
20. To develop more professional HR practices	1,619	21.2%	3,527	25.5%	0.000***
21. To create a culture of employee engagement	1,604	51.7%	3,518	57.6%	0.000***
22. To increase the social and environmental benefits of the business	1,606	47.5%	3,523	49.1%	0.280
Personal Ambition					
23. To have greater flexibility for my personal and family life	1,605	81.1%	3,480	81.5%	0.751
24. To have considerable freedom to adapt my own approach to work	1,602	79.3%	3,481	81.4%	0.076*
25. To have a chance to build great wealth or a very high income	1,602	39.3%	3,480	43.2%	0.008***
26. To fulfil a personal vision of becoming a successful business leader	1,605	42.1%	3,480	45.7%	0.014**
27. To build a business to hand on to my family	1,590	46.2%	3,456	40.7%	0.000***
28. To be able to retire	1,601	62.5%	3,477	64%	0.323

Table 3: Marginal effects for the probability of innovation				
Logit	(1)	(2)	(3)	(4)
VARIABLES	New to Firm Product innovation	New to Market Product Innovation	Process innovation	Innovation
Urban vs Rural (0/1)	0.030*	0.023**	0.026*	0.035**
	(0.016)	(0.011)	(0.015)	(0.017)
IMD Quantiles:				
1.First	0.030	0.010	-0.008	0.006
	(0.023)	(0.016)	(0.021)	(0.024)
2.Second	0.021	0.002	0.013	0.013
	(0.019)	(0.013)	(0.018)	(0.020)
3.Third	0. 024	0.018	-0.002	0.015
	(0.019)	(0.014)	(0.017)	(0.020)
Ambition (business):				
To build a national and/or international business	0. 091***	0.060***	0.064***	0.12***
	(0.016)	(0.011)	(0.015)	(0.018)
To keep my business similar to how it operates	-0.095***	-0.052***	-0.088***	-0.122***
	(0.015)	(0.010)	(0.013)	(0.016)
To grow my business rapidly	0.051***	0.025**	0.045***	0.057***
	(0.015)	(0.010)	(0.013)	(0.016)
To develop more professional HR practices	0.013	-0.003	0.032**	0.027
	(0.017)	(0.012)	(0.015)	(0.018)
To create a culture of employee engagement	0.073***	0.024**	0.087***	0.101***
	(0.015)	(0.011)	(0.014)	(0.015)
Ambition (Personal):				
To have greater flexibility	-0.007	0.001	0.001	-0.008
	(0.018)	(0.013)	(0.017)	(0.019)
To have considerable freedom	0.016	0.007	0.001	0.008
	(0.018)	(0.013)	(0.017)	(0.019)
To have a chance to build great wealth	-0.018	-0.006	-0.005	-0.030*
	(0.015)	(0.010)	(0.013)	(0.015)
To fulfil a personal vision of becoming a successful business leader	0.009	0. 012	0.014	0.000
	(0.015)	(0.010)	(0.014)	(0.015)
To build a business to hand on to my family	0.016	0.010	0.014	0.027*
	(0.015)	(0.010)	(0.013)	(0.015)
Controls:				
Digital innovation (0/1)	0.081***	0.058***	0.106***	0.100***
	(0.017)	(0.014)	(0.016)	(0.016)
Founder (0/1)	0.061***	0.039***	-0.021	0.027*
	(0.014)	(0.010)	(0.013)	(0.015)
Home Based (0/1)	0.021	0.009	0.057***	0.053***
	(0.014)	(0.010)	(0.013)	(0.014)
Family Owned (0/1)	0.013	-0.007	0.010	0.010
	(0.015)	(0.010)	(0.014)	(0.016)
#Current employment	0.006*	0.004*	0.008**	0.008**
	(0.003)	(0.002)	(0.003)	(0.003)
Previous Experience (0/1)	0.086***	0.039***	0.059***	0.097***
	(0.013)	(0.009)	(0.012)	(0.014)
Exporting (0/1)	0.082***	0.060***	-0.009	0.060***
	(0.015)	(0.010)	(0.014)	(0.016)
Training Practice (0/1)	0.063***	0.019*	0.052***	0.076***
	(0.016)	(0.012)	(0.016)	(0.016)
Networking (0/1)	0.028**	0.005	0.027**	0.036**
	(0.014)	(0.010)	(0.012)	(0.014)
Industry dummies:	Included	Included	Included	Included
Regional dummies:	Included	Included	Included	Included
Observations	4,551	4,485	4,546	4,545
LR chi2(40)	551.43***	388.83***	520.31***	687.74***
Pseudo R^2	0.09	0.11	0.10	0.11
Pr(|T| > |t|) = *p<0.1, **p<0.05, ***p<0.001				

Table 4: Marginal effects for the probability of digital innovation			
Logit	(1)	(2)	(3)
VARIABLES	Digital innovation	Established Digital innovation	Emerging Digital innovation
Urban vs Rural (0/1)	-0.008	-0.006	0.009
	(0.015)	(0.016)	(0.016)
IMD Quantiles:			
1.First	-0.015	-0.053**	0.013
	(0.022)	(0.024)	(0.023)
2.Second	0.021	-0.001	0.047**
	(0.018)	(0.020)	(0.020)
3.Third	0.019	0.014	0.044**
	(0.016)	(0.018)	(0.019)
Ambition (business):			
To build a national and/or international business	0.064***	0.065***	0.070***
	(0.018)	(0.019)	(0.018)
To keep my business similar to how it operates	-0.065***	-0.072***	-0.052***
	(0.015)	(0.016)	(0.016)
To grow my business rapidly	0.010	0.034**	0.006
	(0.015)	(0.016)	(0.016)
To develop more professional HR practices	0.022	0.020	0.027
	(0.017)	(0.018)	(0.018)
To create a culture of employee engagement	0.049***	0.041***	0.040***
	(0.014)	(0.015)	(0.015)
Ambition (Personal):			
To have greater flexibility	0.030*	-0.001	0.052***
	(0.016)	(0.018)	(0.018)
To have considerable freedom	0.027*	0.042**	0.060***
	(0.016)	(0.018)	(0.018)
To have a chance to build great wealth	0.029**	0.052***	-0.002
	(0.014)	(0.015)	(0.015)
To fulfil a personal vision of becoming a successful business leader	0.028**	0.037**	0.004
	(0.014)	(0.015)	(0.015)
To build a business to hand on to my family	-0.007	-0.002	-0.013
	(0.014)	(0.015)	(0.015)
Controls:			
Product innovation (0/1)	0.061***	0.073***	0.063***
	(0.014)	(0.015)	(0.015)
Process innovation (0/1)	0.102***	0.096***	0.104***
	(0.017)	(0.017)	(0.017)
Founder (0/1)	0.017	0.025*	0.025*
	(0.013)	(0.014)	(0.014)
Home_based (0/1)	0.030**	0.034**	0.021
	(0.013)	(0.014)	(0.014)
Family_owned (0/1)	0.013	0.004	-0.032**
	(0.014)	(0.015)	(0.015)
#Current employment	0.006**	0.006*	0.011***
	(0.003)	(0.003)	(0.003)
Previous experience (0/1)	0.048***	0.033**	0.049***
	(0.013)	(0.014)	(0.014)
Exporting (0/1)	0.077***	0.075***	0.057***
	(0.015)	(0.016)	(0.016)
Training practice (0/1)	0.039***	0.040**	0.088***
	(0.014)	(0.016)	(0.015)
Networking (0/1)	0.023*	0.018	0.030**
	(0.013)	(0.014)	(0.014)
Industry dummies:	Included	Included	Included
Regional dummies:	Included	Included	Included
Observations	4,523	4,523	4,523
LR chi2(41)	572.84***	530.96***	808.94***
Pseudo R^2	0.11	0.09	0.13
Pr(|T| > |t|) = *p<0.1, **p<0.05, ***p<0.001			

Annex

Urban and rural businesses in the Micro-business Britain survey

Table A1 details the distribution of responses to the Micro-business Britain Survey (in England and Wales) by the ten-fold urban-rural classification and the number of micro-businesses in the corresponding areas. Table A1 indicates that urban city and town is most common location with 68.5 per cent of total England and Wales LSBS responses being classified as urban and the remaining 32.5 per cent classified as rural. This compares to 33 per cent of all English registered businesses being classified as rural in the Inter-Departmental Business Register (DEFRA, 2016).

It is important to note here that the businesses within each of the sub-urban and sub-rural categories are unevenly distributed. As can be seen in Table A1, only 2.0 per cent and 0.7 per cent of the businesses are located in `Urban minor conurbation` and `City and Town in a Sparse Setting`, respectively whereas about 66 per cent of the businesses are located in `urban major conurbation or city and towns`. In addition, collectively `Town and Fringe in a sparse setting`, `Village in a sparse setting` and `Hamlets and Isolated dwellings in a sparse setting` sub-categories make up to only 5 per cent of the whole sample.

Table A1: Standard Urban and Rural classification in the UK

Category	Sub-category	No of responses	% of responses
1 -Urban	Major Conurbation	1,202	22.98
2-Urban	Minor Conurbation	105	2.01
3-Urban	City and Town	2,241	42.85
4-Urban	City and Town in a Sparse Setting	36	0.69
5-Rural	Town and Fringe	490	9.37
6-Rural	Town and Fringe in a Sparse Setting	90	1.72
7-Rural	Village	415	7.93
8-Rural	Village in a Sparse Setting	57	1.09
9-Rural	Hamlets and Isolated Dwellings	487	9.31
10-Rural	Hamlets and Isolated Dwellings in a Sparse Setting	107	2.05
Total for England and Wales		**5,230**	**100.00**

Footnotes

1. Other factors have also been linked to firms' innovative capacity: their capacity develop new markets nationally and abroad, adapt to new trends and technologies, increase productivity or cost efficiency, (Dobbs and Hamilton, 2007; Freel and Robson, 2004; Penrose, 1995); and, their capacities to the specific challenges or opportunities brought by their external environment (North and Smallbone, 1996; Smallbone and North, 1999a, Smallbone et al., 1999b; Westhead et al., 2004).

2. The MBBS survey originally surveyed about 6,250 micro-businesses in England, Wales, Scotland and Northern Ireland. However, due to lack of urban/rural identifier in Scotland and Northern Ireland sample, we conducted the empirical analysis only on the sub-sample comprising 5,230 micro-businesses in England and Wales.

3. Other factors have also been linked to firms' innovative capacity: their capacity develop new markets nationally and abroad, adapt to new trends and technologies, increase productivity or cost efficiency, (Dobbs and Hamilton, 2007; Freel and Robson, 2004; Penrose, 1995); and, their capacities to the specific challenges or opportunities brought by their external environment (North and Smallbone, 1996; Smallbone and North, 1999a, Smallbone et al., 1999b; Westhead et al., 2004).

4. Based on the OECD Oslo manual's Rypestøl and Aarstad (2018) defined innovation as 'the implementation of a 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' (OECD/Eurostat 2005, 46).

5. There may also be an indirect learning-by-using effect related to growth ambition if in previous periods more ambitious firms were early adopters of other digital technologies (McWilliams and Zilbermanfr, 1996). These capabilities may increase firms' absorptive capacity and their ability to effectively use new technologies, increasing the benefit-cost ratio and the probability of adoption.

6. Table A1 provides a breakdown of survey responses by broad sector.

7. Weighting strategies varied slightly between countries depending on the aggregate statistics available. Details are available from the authors on request.

8. See https://www.gov.uk/government/collections/english-indices-of-deprivation.

9. Regions were then classified as 'rural' if more than 50 per cent of the population live in rural local administrative units; 'intermediate' if between 15 and 50 per cent live in rural local units; and 'urban' if less than 15 per cent live in rural local units.

10. See Martinovic and Ratkaj (2015) for a recent application of the OECD approach based on population density to the case of Serbia.

11. The allocation of specific geographies to each category also depends significantly on differences in surface area of the administrative units – NUTS2 or NUTS3 (Dijkstra and Poelman, 2010).

12. In Dijkstra and Poelman (2010), urban areas are distinguished from intermediate areas using a marginally different threshold (20 per cent of rural grid squares) to that in the original OECD classification. Dijkstra and Poelman (2010, p. 245) suggest this change is made to 'ensure that the population share in predominantly urban regions does not differ too much from the original OECD classification applied to NUTS3 regions.

13. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/539241/Guide_to_applying_the_rural_urban_classification_to_data.pdf

14. Note we exclude from each digital adoption model prior adopters of each technology. That is the adoption model for CRM excludes firms which adopted CRM in prior periods.

15. These are: Business referral networks, Chambers of Commerce, LinkedIn, Sector or Trade Associations, the Federation of Small Businesses (FSB), the Institute of Directors (IoD).

16. Marginal effects pertaining to industry dummies are not presented in table 3 and table 4 to save space. These results are available upon request.

17. Tiwasing et al. (2019) used the Propensity Score Matching (PSM) method to analyse the Longitudinal Small Business Survey (LSBS) and found no significant differences between rural and urban firms on the likelihood to adopt product or process innovation in Northern Powerhouse and Midlands Engine areas. However, the statistical significance of urban effect was sensitive to inclusion of London in the sample. Following Tiwasing et al. (2019) methodological approach, we also employed the PSM method to be able to check the robustness of the results reported in this paper. In line with Tiwasing et al. (2019) analysis, we also found no statistically significant difference between the rural and urban micro-businesses on the likelihood to adopt any type of innovation, including digital technologies. To further consolidate these results, we excluded London from the sample and the results remained robust. Hence, we do not discuss the results pertaining to PSM method. The results are available upon request from the authors of this paper.