

Productivity of the UK's small and medium sized enterprises: insights from the Longitudinal Small Business Survey

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Productivity of the UK's small and medium sized enterprises: insights from the Longitudinal Small Business Survey

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EXECUTIVE SUMMARY

Purpose

Since the 2007-08 Global Financial Crisis (GFC), the UK's aggregate productivity growth, as measured by output per worker, has deteriorated. This deterioration is not only significant when compared to the UK's previous experience, but also when compared to the performance of other advanced nations, such as the G7 nations, of which the UK is a member. Improvements in productivity performance are therefore a major economic challenge, especially in the context of ensuring the nation's long-run wellbeing [1].

Inspired by the UK's recent productivity experience, in this study we seek to derive productivity insights from the firm-level micro data in the two waves of the UK's Longitudinal Small Business Survey (LSBS).

Aim

The aim of this analysis is to understand the factors underpinning productivity gains and shortfalls in small and medium sized enterprises (SMEs). SMEs are defined as those firms with less than 250 employees. We undertake econometric analysis of the LSBS data and explore the heterogeneity of effects across sectors. The panel data from such a large sample, with access to a large number of variables collected in 2015 and 2016, allows us to identify the explanatory factors at play in affecting productivity, especially variables such as strategic management, management capability, skills, collaboration and networks, amongst others, as these potentially affect productivity improvements. The longitudinal nature of the data allows us to examine both contemporary and lag economic effects, enabling us to better understand some of the contested matters affecting productivity.

Design/Methodology/Approach

We use the firm-level longitudinal data in the LSBS and examine changes in measured labour productivity (as proxied by turnover per unit of labour) in UK firms through an Ordinary Least Square (OLS) modelling approach to estimate the models.



Findings

We find:

- A significant and positive correlation between measured labour productivity and measures of strategic management, business capability, business network, training and the technology intensity of firms.
- Among different explanatory variables, Strategic Management Practices, Training and Management Capability (Model 2) show a positive and significant influence on labour productivity.
- Among different specific capabilities (Model 5), strategic planning, as measured by a plan to improve leadership capability and a plan to sell goods to new overseas markets (a measure of innovation), significantly affects labour productivity.
- Management capability to access external finance and training to improve IT skills has significant and positive effects on productivity.
- Having their own website significantly affects productivity in firms positively as compared to firms without a website.
- Across the different industry sectors, firms in wholesale/retail and construction have greater and significant positive effects on productivity as compared to the reference category (primary sector in this case). While finance/real estate does have positive effects on productivity, the coefficients are not significant. In manufacturing the effect is mixed and in all other sectors the impact is lower than the reference category.
- Firms more than 20 years of age are more productive than firms in other age cohorts. Medium sized firms are found to be more productive than micro and small firms.
- The trade coefficient is positive and significant, which means that firms with higher intensity of international trade show better productivity performance.

Practical Implications

A range of practical implications arise, most pertinent being:

• To improve firm-level strategic management practices, managerial capability and training to restore productivity performance of UK firms;



- To improve IT skills and innovation capability of firms;
- To encourage firms to go global; and
- To assist younger and smaller firms to improve managerial and strategic capabilities.



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1. INTRODUCTION

Since the Global Financial Crisis (GFC) of 2007-08, the UK's aggregate productivity growth, as measured by output per worker, has deteriorated (Figure 1). This deterioration is not only significant when compared to the UK's previous experience, but also when compared to the performance of other advanced nations, such as the G7, of which the UK is a member (Figure 2).¹ Improvements in productivity performance are therefore a major economic challenge, especially in the context of ensuring the nation's long-term wellbeing [1].



Figure 1: Annual growth rate of output per worker, UK, 1961-2016

Source: Office for National Statistics [2]

¹ Other G7 countries are Japan, US, Germany, Italy, France and Canada.







Source: Office for National Statistics [2]

Inspired by the UK's recent productivity experience, we seek to derive productivity insights from the firm-level micro data in the two waves of the Longitudinal Small Business Survey (LSBS). Using the primary data on labour productivity, firm size, sector, intensity in international trade, management capability, training, networking and technology intensity for the 5,844 firms in the 2015 and 2016 panels [3], we explore the determinant of labour productivity in UK small and medium sized enterprise (SMEs). This is important as we know that from 2015 to 2016 some 47% of firms experienced a decrease in productivity, while a significantly lower proportion (42%) of firms in the panel experienced a productivity increase [3]. Our analysis helps to unveil what is contributing to this fundamental productivity problem and therefore what support might be needed to redress the problem.

Many studies have focused on productivity generally, but not specifically the productivity performance of SMEs. In developed and developing nations, SMEs make up the overwhelming proportion of the business population [4-6], but they face different opportunities and constraints to those of large firms [7]. In the UK, SMEs make up more than 99% of all total private sector firms, and they employ about 60% of all private sector employees [3]. SMEs face many obstacles to improving business performance [3]. Through this study of the productivity performance drivers in UK SMEs, we unpack some of the factors influencing productivity gains and shortfalls.



2. RESEARCH AIM

The aim of this research is to understand the factors underpinning productivity gains and shortfalls in SMEs, defined as those firms with less than 250 employees. We aim to do this through an econometric analysis of the LSBS data. The LSBS data is collected from more than 7000 firms across a large number of variables. The analysis we undertake allows us to identify some explanatory factors and the roles they play in influencing productivity, especially variables such as strategic management, management capability, skills, collaboration and networks and technology intensity as these potentially affect productivity improvements. The longitudinal nature of the data allows us to examine both contemporary and lag economic effects, enabling us to better understand many of these contested research issues.

3. LITERATURE REVIEW: INSIDE PRODUCTIVITY

What factors propel productivity growth remains an important research issue [8-12]. A number of studies emphasise the key roles that innovation and human capital accumulation play in increasing productivity growth [13-17]. However, there is a lack of empirical research drawing on firm-level data to unlock knowledge about productivity drivers.

A number of studies highlight the roles of the strategic management practices to increase a firm's labour productivity. Qu and Cai [18] discuss the impact of increasing productivity by increasing the skills of the workforce, while others discuss the influence of various factors upon firm labour productivity, such as: the leadership capability of managers [19]; capital investment [20]; the development and launch of new products and services [21]; the introduction of new work practices [22, 23]; and, entering new international markets [24].

In several studies the impact of management capability on labour productivity has been emphasised. For example, Ingram and Fraenkel [25] look to the managers' capability to manage people, while Silvestro [26] considers the importance of business plans and strategy. Other studies produce findings of the effects on labour productivity of the capability of managers to introduce new products and services [21], access finance from external sources [27], and improve operations [28].



Another important factor that affects a firm's labour productivity is business networking. Business networking occurs in a number of ways including social media business networks [29, 30], and general business networking [31]. Business networking in various ways stimulates knowledge sharing, with possible effects of increased productivity (Ferreira and Du Plessis, 2009).

The influence of management training is also examined by various authors. For example, McEwen [32] studies the impact of tertiary education on management communication skills. Training improves quality and efficiency of current employees and thereby contributes to the improvement of productivity.

There have been some studies examining productivity growth in the UK [33, 34]. They suggest, in general, that firms with higher productivity growth "are more likely to grow faster in sales and in turn, HGFs [high growth firms] are more likely to achieve higher productivity growth" [22]. Du and Temouri [22] connect total factor productivity growth in UK firms to sales growth. Others associate UK firm productivity growth with investment in wide-ranging productivity concepts such as innovation [35], intangible assets [36, 37], or the knowledge economy [38]. These concepts also include factors such as research and development (R&D), as studied by O'Mahony and Vecchi [39], and occupational mismatch [40]. Rizov, Croucher [41] examine the effect of incentives (the UK national minimum wage) on productivity, and Burdett, Carrillo-Tudela [42] discuss the effects of wage variance upon the productivity of UK workers. A handful of other studies consider the relationship between information and communication technology (ICT) and productivity growth in the UK [43-45]. Martínez - Caro and Cegarra - Navarro [46] investigate a sample of SMEs in the UK telecommunications sector to determine the impact of e-business on capital productivity.

Some recent research investigates the role of ICT upon productivity growth across a number of OECD countries including the UK [47-52]. Indeed, the slowing effect of ICT on productivity growth in the UK in the period post-1995 is mirrored in a number of studies that compare the productivity gap between the US and the European Union (EU) [53-55]. In general ICT reduces transaction cost of business, enables better communication with customers, expands networks and improves quality and quantity of production, thereby contributing to the improvement of productivity (Melville et al, 2004). However, the marginal impact of ICT capital is



higher when it is combined with intangible capital (Brynjolfsson & Hitt, 2000). This finding is consistent with the resource-based view of the firm, which implies building core competencies surrounding a bundle of resource-that a firm controls (Barney, 1991, 1997; Penrose, 1959). Leveraging returns from any kind of tangible investment therefore requires adjustments to quality attributes, such as management, and labor skills and 'know how' (Teece, 1998), and 'culture' (Barney, 1991).

This brief overview of the literature on labour productivity suggests some factors explaining productivity. However, there is a lack of understanding about the ways intangible factors, such as, strategic management practices, managerial capabilities, types of skills, business networking can influence productivity. This may be due to problems in quantifying these factors [56, 57] or because of the nature of samples (small, single industry) and/or data (cross-sectional, time-bound) used in analyses. While single industry studies can be beneficial, findings may not be generalisable across the economy. Similarly, cross-sectional data does not capture lag effects [58-61] and so findings are only partial. This study fills the gaps in the literature.

4. ANALYSIS AND RESULTS

4.1 Data

The data analysed for this report are from the first two waves of firm-level data for the UK's LSBS for the period of 2015 and 2016. The LSBS has been conducted with the objective of improving understanding of the outcomes, drivers, and constraints of business performance of the UK's SMEs. The balanced panel of LSBS contains data from 5844 firms.

The main variable of interest is measured productivity, a measure that describes the relationship between the output and the inputs that require to produce output[62]. Labour productivity is defined as output per unit of labour and can be measured by the formula (Equation 1):

 $Measured \ Labour \ Productivity_{i,t} = \frac{Value \ added_{i,t}}{Number/hours \ of \ workers_{i,t}}$



In Equation (1), *i* refers to unit of analysis (a firm in this case) and *t* refers to a time period.

The data for value added is not available in the LSBS, therefore we used turnover value instead of value added to compute productivity. Turnover includes the value of intermediate inputs, while should ideally be excluded when measuring productivity. Given the unavailability of the intermediate inputs data in the LSBS, we assume that share of intermediate inputs is roughly constant to the value of turnover so that the growth of intermediate consumption is roughly proportional to the growth of output. Similarly, total employment is a less recommended measure of labour input as it does not reflect changes in work time and quality of labour. However, the data for hours worked or the quality of labour is not available from the LSBS. The proxy measure of measured labour productivity used in this study is found be consistent with the literature [63, 64].

In the LSBS, a total of 7279 firms participated in the survey in both years. However, a total of 5607 firms and 5937 firms provided turnover data for 2015 and 2016, respectively. For 'number of employees' we only consider the full-time employees, not the casual and contract staff, as the dataset does not provide the hours worked by these two categories. A total of 5974 firms provided employment data for 2015 and 7184 firms provided employment data for 2016.

We exclude firms recorded as having more than 250 employees as we are only focusing on SMEs.² After adjusting the missing values for both turnover and employment, data for labour productivity can be computed for 4601 firms in 2015 and 5851 firms in 2016.

The explanatory variables in this study include strategic management practice, management capability, business network, training, collaboration and partnership and technology intensity. Additional control variables in the study include economic sector, firm age, firm size and international trade. Given below are the definitions for the variables used in the study.

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² Seven and 25 firms reported to have more than 250 employees in 2015 and 2016, respectively.



Strategic Management Practices (STRA) This construct captures the aspects of strategic management. This means having and implementing an overall plan of action which defines the competitive position of the firm. The components covered under this construct are:

R4A_2016: Plans over next three years - increase the skills of workforce;

R4B_2016: Plans over next three years - increase the leadership capability of managers;

R4C_2016: Plans over next three years - capital investment;

R4D_2016: Plans over next three years - develop and launch new products/services);

R4E_2016: Plans over next three years - introduce new working practices;

R4G_2016: Plans over next three years - sell to overseas markets that are new for your business.

The components come with a dichotomous scale, where 'zero' indicates there is no plan, and 'one' indicates there is a plan of action.

Management Capability (*MCAP*) MCAP refers 'to the potency of an organisation's collective management competencies as they can be applied to achieve the desired outcome' [65]. The survey includes a number of capability questions (F4.1 – F4.5) in a Likert scale (1-Very Poor, 5-Very Strong). The questions are collected in 2015 only. Our management capability construct consists of five components:

F4.1_2015: Capability for people and management;

F4.2_2015: Capability for Developing and Implementing a business plan and strategy;

F4.3_2015: Capability for developing or introducing new products or services;

F4.4_2015: Capability for accessing external finance; and

F4.5_2015: Capability for operational improvement.

Business Network (BNET) BNET refers to the firm's ability to maintain its relationship with external parties, such as suppliers, customers, third-party



developers, distributors, and others. Networks allows access to resources not under firms control in a cost-effective way, thereby helping firms grow [66]. In the LSBS survey, there are four indicators of a business network:

K20A_2015: A social media business network such as LinkedIn;

K20B_2015: A local Chamber of Commerce;

K20C_2015: A formal business network, e.g., one that meets regularly; and

K20D_2015: An informal business network that meets socially to discuss mutual business interests.

Managers' Training (TRAIN) TRAIN refers to the formal training for the managers to improve skills. Based on the availability of data, the construct *TRAIN* consists of six components. They are:

N5A_2015: Training for managers - Leadership and management skills;

N5B_2015: Training for managers - IT Skills;

N5C_2015: Type of training for managers - Health and Safety;

N5D_2015: Type of training for managers - Technical, practical or job-specific skills; and

N5E_2015: Type of training for managers - Teamworking skills.

Business Support (LINKS) LINKS refers to awareness of business support organisations. Based on availability of data, the construct *LINKS* consists of three components. They are:

K14A_2016: Awareness of business support organisations - tools for a business section on Government website (England);

K14B_2016: Awareness of business support organisations - Local enterprise partnership (England); and

K14C_2016: Awareness of business support organisations - Local Growth Hub (England).

Technology Intensity (*ITS*) ITS is measured in terms of information technology (IT) intensity of firms. Based on availability of data, the construct *ITS* consists of three factors. They are:



O7A_2015: Type of technology used - You have access to the internet for work purposes;

 $\ensuremath{\mathsf{O7B}}\xspace_2015$: Type of technology used - Your business has its own website; and

O7C_2015: You use a third party website to promote or sell your goods and services, e.g., Amazon, Etsy, Ebay.

Table 1 provides some statistical properties of the explanatory variables. All of these variables are in dichotomous forms, taking either "0", "1" or "1", "2" values. Business Networks and Technology Intensity have highest rate response (7279 observations), while there are only 2990 observations for the Training questions. This means that the N values for likewise cases is 1855 as a result of the missing values. A mean value close to maximum indicates firms' capability improvement in the particular aspect. For example, for Technology Intensity, a value of 0.97 indicates that most employees have access to the internet for work purposes.



Table	1: Desc	riptive S	tatistics	of Ex	planatory	Variables
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	Number of observations (N)	Minimum	Maximum	Mean
Strategic Management Practices (STRA)				
Increase the skills of the workforce	7279	0	1	0.67
Increase the leadership capability of managers	7279	0	1	0.46
Capital investment (in premises, machinery etc.)	7279	0	1	0.40
Develop and launch new products/services	7279	0	1	0.39
Introduce new work practices	7279	0	1	0.43
Sell to overseas markets that are new to your business	7279	0	1	0.20
Canability for people management	53/6	1	2	1 81
	3340	1	2	1.01
Capability for developing and implementing a business plan and strategy	/146	1	2	1.64
Capability for developing and introducing new products or services	6/11	1	2	1.60
Capability for accessing external finance	5398	1	2	1.49
Capability for operational improvement	7009	1	2	1.71
Business Networks (BNET)				
A social media business network such as LinkedIn	6517	0	1	0.52
A local Chamber of Commerce	6517	0	1	0.21
A formal business network e.g. one that meets regularly	6517	0	1	0.35
An informal business network that meets socially to discuss mutual business interests	6517	0	1	0.31
Training (TRAIN)				
Leadership and management skills	2990	0	1	0.57
IT skills	2990	0	1	0.42
Health and safety	2990	0	1	0.73
Technical, practical or job-specific skills	2990	0	1	0.88
Teamworking skills	2990	0	1	0.47
Business Support (LINKS)				
Tools for business section on .Gov website	6274	0	1	0.25
Local Enterprise Partnership	6274	0	1	0.47
Local growth hub	6274	0	1	0.24
Technology Intensity (ITS)				
Types of technology used: You have access to the internet for work purposes	7279	0	1	0.97
Types of technology used: Your business has its own website	7279	0	1	0.81
Type of Technology used: You use a third party website to promote or sell goods	7279	0	1	0.18
N (likewise)	1855			



4.2 Labour Productivity

Table 2 provides summary statistics for labour productivity for 2015 and 2016. The values are in natural logarithms and the sample adjusted for outliers. As shown in Table 2, the values range from 7.13 to 14.65, with a mean value of 10.9 in 2015 and the value range 7.07 to 14.52, with a mean value of 10.8 in 2016. Overall, there has been a slight decrease in dispersion in data between 2015 and 2016, the value of standard deviation decreases from 1.07 in 2015 to 1.05 in 2016. The values for Skewness do not show any biases although the Kurtosis value indicates that the distribution has more data in the tails relative to its peak. We assume that the data for the variables are roughly normally distributed.

		Labour Productivity	Labour Productivity				
		2015, Log Scale	2016, Log Scale				
Number of observations	Valid	4564	5810				
	Missing	2715	1469				
Mean		10.9	10.8				
Median		10.9	10.8				
Std. Deviation		1.07	1.05				
Skewness		0.014	0.045				
Std. Error of Skewness		0.036	0.032				
Kurtosis		0.582	0.486				
Standard Error of Kurtosis		0.072	0.064				
Minimum		7.13	7.07				
Maximum		14.65	14.52				
Percentiles	25	10.23	10.13				
	50	10.90	10.82				
	75	11.51	11.51				

Table 2: Labour Productivity Summary Statistics

Figure 3 shows the growth of labour productivity in UK SMEs in 2016 relative to 2015. The scatter plot with the positive fitted line shows improvement of productivity in 2016 from the previous year.



Figure 3: Labour Productivity in 2016 relative to 2015 in UK SMEs



Growth in Labour Productivity in 2016

The dataset allows us to compute labour productivity growth from 2015 to 2016. The growth data is available for 4157 firms. The growth in log productivity range from -7.18% to 5.70%, with mean 0.03% and standard deviation of 0.70%. Figure 4 shows a histogram of the growth in log labour productivity data, with the black line showing the normal curve on the histogram.







Growth rates vary across sectors as Figure 5 shows. The sectors in which labour productivity improved include Health, Administrative Services, and Finance/Real Estate Services. Significant shortfalls in productivity occurred in Education and Primary sectors.



Figure 5: Growth of 2016 Log Labour Productivity across Economic Sector

Figure 6 shows the growth of log labour productivity by firm size in 2016. As shown in Figure 6, growth of labour productivity varies by firm size, with micro firms (1-4 employees), on average, experiencing a lower productivity growth.

Figure 6: Growth of Log Labour Productivity in 2016 by firm size





4.3 Factors Affecting Labour Productivity

Crosstabs and correlation analyses are widely used methods to find interrelationships and interactions between variables. In order to perform crosstabs analysis, both labour productivity and related variables are required to be in categorical forms. We used percentiles to develop a measure for a categorical variable for labour productivity (Table 3).

Table 3: Labour Productivity Percentiles								
Percentiles	25% 50%		75%					
	10.13	10.81	11 51					

.

The construction of the variable is as follows:

1 = Labour productivity less than 10.13;

2= Labour productivity equal to or greater than 10.13 and less than 10.81;

3 = Labour productivity equal to or greater than 10.81 and less than 11.51;

4=Labour productivity equal to or greater than 11.51.

In Table 4 we present the results from the crosstabs and correlation analyses with some interesting findings. We find a significant positive correlation between labour productivity and other explanatory variables in the model (Column 1). Two different statistics are presented in Table 4: one is Pearson's Chi-Square (Column 2), which shows interrelationships and interactions between variables, and another is Phi Correlation Coefficient (Column 3), which explains the strength of the relationship. The phi coefficient is appropriate when the variables are dichotomously measured. The results indicate a significant and positive association between labour productivity and measures of strategic management, business capability, business network, training and technology intensity.



Table 4: Crosstabs and Correlation Analysis

(1)	(2)	(3)
	Crosstab	Correlation
	Cha	ange in Labour
		Productivity
	Pearson's	Phi Corr.
	Chi-	Coefficient
Stratagic Management Practices (STRA)	Square	
Increase the skills of the workforce	31 /6a	0 08 a
Increase the leadership capability of managers	1/ QQa	0.00 0.05 a
Capital investment (in premises, machinery etc.)	67 70 ^b	0.00 0.11ª
Develop and launch new products/services	33.26ª	0.09 ^a
Introduce new work practices	7.45°	0.04 ^a
Sell to overseas markets that are new for your business	164 25ª	0 17ª
Management Canability (MCAP)	104.20	0.17
Canability for people management	26 94ª	0 08ª
Capability for developing and implementing a business plan and strategy	19 21 ª	0.00 ^b
Capability for developing and introducing new products or services.	2.99	0.02
Capability for accessing external finance.	56.78ª	0.12ª
Capability for operational improvement.	1.51 ª	0.017
Business Networks (BNET)		
A social media business network such as LinkedIn	39.94 ª	0.09 ^a
A local Chamber of Commerce	34.26 ª	0.08 a
A formal business network e.g. one that meets regularly	0.75	0.012
An informal business network that meets socially to discuss mutual	6.23	0.04 ^c
business interests		
Managers' Training (TRAIN)		
Leadership and management skills	9.87 ^b	0.07°
IT skills	13.67ª	0.08ª
Health and safety	9.29 ^b	0.07 ^b
Technical, practical or job-specific skills	6.97°	0.06 ^c
Teamworking skills	6.92 ^c	0.06 ^b
Business Support (LINKS)		
Tools for Business section on .Gov website	4.35	0.03
Local Enterprise Partnership	5.85	0.04
Local Growth Hub	8.19	0.04
Technology Intensity (ITS)		
Types of technology used: You have access to the internet for work	44.72 ^a	0.09 ^a
purposes	20.263	0.00 a
Types of technology used. You use a third party website to promote/coll	30.30 ° 7 8/b	0.08 ª
acods	7.04-	0.04*
goods		

Notes: Superscipt a, b and c refer to significance levels at 1%, 5%, and 10% respectively.



4.4 Modelling Labour Productivity

The descriptive analysis above provides some insights on the characteristics of the data and possible association among the variables, but they do not tell us how significant these are in explaining productivity. Accordingly, the aim in this section is to understand the factors that propel productivity gains and shortfalls in SMEs in the UK. Below we provide econometric analysis in this context.

Based on the literature review presented in Section 3, we hypothesise that a number of capability indicators affect firm-level labour productivity positively. The generic representation of the model (Equation 2) is as follows:

 $LnLP_{it} = \alpha + \beta_1 STRA_{it} + \beta_2 MCAP_{it} + \beta_4 BNET_{it} + \beta_5 TRAIN_{it} + \beta_6 LINKS + \beta_7 ITS_{it} + \beta_8 Z_{it} + \varepsilon_{it}$

where, *LnLP* is the natural logarithm of labour productivity, which is a dependent variable in the model. The explanatory variables are Strategic Management Practices (*STRA*), Management Capability (*MCAP*), Innovation Capability (*ICAP*), Business Network (*BNET*), Training (*TRAIN*), Business Support (*LINKS*) and Technology Intensity (*ITS*). *Z* is a vector for control variables, i.e. economic sector,firm age and international trade. In the equation, *i* refers to firm and *t* refers to time. The dependent variable is a scale variable, while all explanatory variables are categorical variables. The control variables are a set of dummy variables. The term ε_{it} refers to a random error in the regression equation.

Among the explanatory variables, data for *STRA* and *TRAIN* are only available for both 2016 and 2015. Data for *MCAP*, *BNET* and *ITS* are available for 2015 only, while data for *LINKS* are only available for 2016. Therefore, the labour productivity models are estimated for 2016 with contemporaneous effects of *STRA* and *LINKS* and lag effects of other variables.

In Table 5 the reliability estimates for each component of the constructs is provided. The value of Cronbach's Alpha shows the intercorrelations among test items. As can be seen in Table 5, only one of the six categories crosses the acceptable value of Cronbach's Alpha of at least 0.7. For other components, the internal consistency of the components remains weak. The *N* values indicate that Training and Management Capability have 2865 and 3830 observations



respectively, significantly lower than those for other variables. Including these variables will significantly reduce degrees of freedom in the estimated models.

	Cronbach's Alpha	IN
Strategic Management Practices (STRA)	0.69	7279
Increase the skills of the workforce		
Increase the leadership capability of managers		
Capital investment (in premises, machinery etc.)		
Develop and launch new products/services		
Introduce new working practices		
Sell to overseas markets that are new to your business		
Management Capability (MCAP)		3830
People management	0.54	
Developing and implementing a business plan and strategy		
Developing and introducing new products or services		
Accessing external finance		
Operational improvement		
Business Networks (BNET)	0.42	6517
A social media business network such as LinkedIn		
A local Chamber of Commerce		
A formal business network e.g. one that meets regularly		
An informal business network that meets socially		
Training (TRAIN)	0.48	2865
Leadership and management skills		
IT skills		
Health and Safety		
Technical, practical or job-specific skills		
Financial management		
Teamworking skills		
Business Support (LINKS)	0.51	6274
Tools for a Business section on .Gov website – England		
Local Enterprise Partnership – England		
Local Growth Hub – England		
Technology Intensity (ITS)	0.42	7029
Access to the internet for work purposes		
Business has its own website		
Use a third party website to promote or sell your goods or services, e.g. Amazon,		
Etsy or Ebay.		

Table 5: Internal consistency and internal reliability estimates

In Appendix 1 results from the correlation analysis indicate a relatively higher correlation among the components of Strategic Management Practices (Table 1A). In particular, the correlation coefficient between leadership capability and plan to increase the skills of the workforce is found to be 0.52 and the correlation coefficient between introduce new working practices and plan to increase the skills of the workforce is found to be 0.42. The high correlation among explanatory variables may increase the likelihood of multicollinearity in a regression [67].



In Appendix 2 factor analysis results are reported. Factor analysis is a useful tool to extract the principal component from each category. The principal component analysis sees one factor extracted for *STRA*, *MCAP*, *LINKS* and ITS, while two factors are extracted for *TRAIN* and *BNET*.

With this information, we proceed with estimating different variations of Equation 2 using the composite scales developed by factor analysis. All models are estimated using Ordinary Least Square (OLS) methods in "R" statistical software.

In Table 6, the estimated Models 1-4 include the composite indicators for explanatory variables as well as dummies for economic sectors, age, size and international trade. Different variants of Equation 2 are estimated based on intercorrelation of the variables, sample size, and explanatory factors. Among different explanatory variables, Strategic Management Practices, Management Capability, and Training show positive and significant influence on labour productivity.



Table 0. Regression Results.	Model 1	Model 2	Model 2	Model 3
	Beta	Beta	Beta	Beta
Constant	10.92***	10.9***	10.8***	9.69***
Strategic Management Practices (STRA)	0.08**	0.04	0.05*	0.05***
Management Capability (MCAP)	0.03	0.04*	0.04*	0.03**
Rusipess Network 1 (RNET1)	0.02	0.02	0101	
Dusiness Network 7 (DNET7)	0.02	0.02	-	
Business Network 2 (BNET2) Training 1 (TRAIN1) Training 2 (TRAIN2) Business Support (LINKS) Technology Intensity (ITS)	-0.01 0.01 0.07** -0.03 0.02	-0.01 0.04 0.06** -0.03 0.02	- 0.07** -0.03 -	
TRADE Sector Dummy	0.05	0.40***	0.40***	0.43***
Manufacturing	0.05	0.10	-0.10	-0.027
Construction Wholesale/Retail	0.25 0.38**	0.31* 0.36**	0.31* 0.37**	0.15 0.17*
Transport/Storage	-0.37*	-0.38*	-0.36*	-0.44***
Food/Accommodation Information/communication Finance/Real estate Professional Services Administrative Services Education Health Arts/ Entertainment Other convince	-0.87*** -0.17 0.21 -0.37** -0.26 -1.16 *** -1.27 *** -0.82 ***	-0.79*** -0.29 0.24 -0.39** -0.24 -1.10 *** -1.18 *** -0.77 ***	-0.78*** -0.27 0.25 -0.38** -0.24 -1.08*** -1.17 *** -0.75 ***	-0.92*** -0.50** 0.18 -0.39** -0.43*** -1.23 *** -1.27 *** -0.98***
	-0.87***	-0.84 ***	-0.83 ***	-0.82
Firm age: 6-10 years Firm age: 11-20 years Firm age: More than 20 years Firm age: Don't know	0.25 ** 0.17* 0.28 *** 0.37	0.25** 0.16 * 0.27 *** 0.37	0.24** 0.15 * 0.27 *** 0.37	0.14** 0.11* 0.19*** 0.31
Size: 5-9 Size: 10-49 Size: 50-249 R Square Adjusted R Squared	0.06 0.12 0.22*** 0.32 0.31	0.08 0.10** 0.19*** 0.34 0.33	0.09 0.11 0.22*** 0.34 0.33	1.23 1.41 1.52* 0.30 0.29

. . . log of Johour productivity

Estimates reported in Table 6 point to a significant degree of heterogeneity across economic sectors. Among different economic sectors, Wholesale/Retail and Construction firms show a positive and significant effect on labour productivity compared to the reference category (Primary Industry). Finance/Real estate, while affecting labour productivity positively, does not show any statistically significant coefficient. Manufacturing shows mixed results across different models. Other sectors contribute to productivity growth negatively.



Differences in labour prodctivity due to firm size and age are statistically significant. Mature firms (more than 20 years old) are found to be more productive than the younger ones. Similarly, medium sized firms are more productive than micro and small firms.

The coefficient of *TRADE* is found to be highly significant and positive, which means that firms with higher intensity of international trade show better productivity performance.

We did not find any significant effect of *ITS* and *LINKS* on firm level productivity, possibly because these two variables have been narrowly defined in the questionnaire. However, some components of the constructs are found to be significant, which we discuss below.

Individual Capabilities Influencing Labour Productivity

While the regression results above provide useful insights of the effects of broad constructs on labour productivity, it is useful to examine the effects of individual components. We do so by estimating a general model with all 27 components and the control variables and then following a general–to-specific (*gets*) modelling approach to drive a most specific model [68]. The following steps were used:

Step 1: Estimate a general model;

Step 2: Identify and exclude the variable with most insignificant p-value from the estimated model;

Step 3: Run the model and check model fitness as measured by adjusted R squared;

Step 4: Accept the revised model (by omitting a specific component) if adjusted R squared improve;

Step 5: Iterate the process until adjusted R squared reaches the maximum.

The fitness of the estimated model improves as measured by R-squared and adjusted R-Squared when following the *gets* approach.

The results are presented in Table 7which reveals some interesting findings. Strategic planning as measured by plans to improve leadership capability and plans to sell to new overseas markets (a measure of innovation) significantly affect labour productivity. Management capability in accessing external finance and training to improve IT skills are found to have significant and positive effects on



productivity. Having a website affects productivity positively compared to not having a website. Finally, similar to other regressions, trade intensive firms are found to be more productive than others.

Table 7: Regression Results-Specific Capabilities Influencing Labour Productivity

	Model 5
	Beta
Constant Plan: Increase in leadership capability	10.57*** 0.07*
Plan: Sell to new overseas market Capability: Accessing external finance	0.12** 0.12***
Training: IT skills Business has own website	0.15*** 0.18*
International trade <u>Sector Dummy</u>	0.34***
Manufacturing Construction	-0.22 0.185
Wholesale/Retail Transport/Storage	0.19 -0.45***
Food/Accommodation	-0.92***
Information/communication	-0.39***
Professional Services	0.12 -0.47***
Administrative Services	-0.50***
Education	-1.21 ***
Health	-1.31***
Arts/ Entertainment	-0.99***
Other services	-0.94***
	0.4.0**
Firm age: 6-10 years	0.16***
Firm age: More then 20 years	0.20
Firm age: Don't know	0.29
Size	0.201
Size: 5-9	0.16*
Size: 10-49	0.24**
Size: 50-249	0.34***
R Squared	0.36
Adjusted R Squared	0.35
Number of observations	2377



5. CONCLUSIONS

In recent years, labour productivity growth in many advanced countries including the UK has slowed. This has led to a major concern over mainlining productivity momentum in firms and their sustainability in the long-run. Using firm-level data, we sought to assess the impact of several explanatory variables on labour productivity. These factors include strategic management practices, management capability, networks and collaboration, training, technology intensity and trade. Findings suggest:

- A significant and positive correlation between labour productivity with measures of strategic management, business capability, business network, training and IT intensity of firms.
- Among different explanatory variables, Strategic Management Practices, Training and Management Capability (Model 2) show positive and significant influence on labour productivity.
- Among different specific capabilities, strategic planning as measured by a plan to improve leadership capability and a plan to sell goods to new overseas markets (a measure of innovation) significantly and positively affect labour productivity.
- Management capability to access external finance and training to improve IT skills is found to have significant and positive effects on productivity.
- Firms with their own website have better productivity than firms without a website.
- Firms that engage in international trade are found to be more productive than firms focussing solely on the domestic market.
- Across the different industry sectors firms in wholesale/retail and construction have greater and significant positive effects on productivity as compared to reference category (primary sector in this case). While finance/real estate does have positive effects on productivity, the coefficients are not significant. In manufacturing the effect is mixed and in all other sectors the impact is lower than the reference category.



- Firms that are more than 20 years old are more productive than others. Age may indicate experience in decision making, awareness and understanding the external environment, reflecting the ability to better exploit opportunities better.
- UK firms show heterogeneity in productivity on the basis of their age: medium sized firms are more productive than micro and small firms. Larger firms are likely to enjoy economies of scale, overcome capital constraints and improve efficiency, resulting in better productivity performance than smaller firms.
- The Trade coefficient is positive and significant, which means that firms with a higher intensity of international trade showed better productivity performance.

These findings indicate that productivity is more likely to occur in firms where there is an outward focus on markets and which have capable management. The findings imply a need to focus on building strategic capability within firms as well as improve managerial and market innovation capabilities. Training, especially to improve IT skills, may assist in the productivity pursuit while so too does having a website.

Limitations

There are some limitations to our analysis. Although more than 7000 firms participated in the survey, there were significant problems arising form missing data and extreme values. We studied 27 variables affecting labour productivity, in which the likewise case dropped to 1855, which significantly reduced the degrees of freedom for the analyses. Data on training was particularly problematic as there was a low response rate for these questions. The reliability of the components for many constructs was poor, for example , such as business network, technology intensity and training. Data for some key variables, such as management capability, business network, information technology were not collected for both years, making any comprehensive longitudinal analysis problemetic. Finally, there was a lack of a measures of leadership capability, organisational culture, research and development and recent changes in the digital economy – all of which will have



some effect on labour productivity. We suggest some of these matters be addressed before the next wave of LSBS data gathering.



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Appendix 1: Inter-Item Correlation Matrices

	Plans: Increase skills	Plans: Increase the leadership capability	Plans: Capital investment	Plans: Develop and launch new products or services	Plans: Introduce new working practices	Plans: Sell to new overseas markets
Plans: Increase skills	1.00	0.515**	0.294**	0.323**	0.405**	0.173**
Plans: Increase the leadership capability		1.00	0.294**	0.308**	0.414**	0.179**
Plans: Capital investment			1.00	0.251**	0.266**	0.132**
Plans: Develop and launch new products or services				1.00	0.329**	0.335**
Plans: Introduce new working practices					1.00	0.168**
Plans: Sell to new overseas markets						1.00

Table 1A: Strategic Management Practices 2016

Note: **Correlation is significant at the 0.01 level (2-tailed)

Table 1B: Management Capability 2015

		New people and management	Business plan and strategy	New product and service	External finance	Operational management
New people management	and	1.00	0.260**	0.111**	0.117**	0.247**
Business plan strategy	and		1.00	0.243**	0.199**	0.283**
New product service	and			1.00	0.112**	0.167**
External finance					1.00	0.200**
Operational management						1.00

Note: **Correlation is significant at the 0.01 level (2-tailed)



Table 1C: Business Network 2015

	A social media business network	A local Chamber of Commerce	A formal business network	An informal business network
A social media business network	1.00	0.157**	0.176**	0.184**
A local Chamber of Commerce		1.00	0.195**	0.107**
A formal business network			1.00	0.206**
An informal business network				1.00

Note: **Correlation is significant at the 0.01 level (2-tailed)

Table 1D: Training 2015

	Leadership and management skills	IT skills	Health and safety	Technical, practical or job-specific skills	Team working skills
Leadership and management skills	1.00	0.110**	0.120**	-0.033	0.490**
IT skills		1.00	0.059**	0.086**	0.136**
Health and Safety			1.00	0.020	0.187**
Technical, practical or job-specific skills				1.00	0.024
Teamworking skills					1.00

Note: **Correlation is significant at the 0.01 level (2-tailed)

Table 1E: Business Support 2016

	Government support	Local enterprise partnership	Local hub	growth
Government support	1.00	0.193**	0.182**	
Local enterprise partnership		1.00	0.395**	
Local growth hub support			1.00	

Note: **Correlation is significant at the 0.01 level (2-tailed)



Table 1F: Technology Intensity 2015

		-		
	Access to the internet for work purposes	Business has its own website	Use a third-party website to promote or sell your goods or service	Goods and services can be ordered directly from own website
Access to the internet for work purposes	1.00	0.203**	0.036**	0.096**
Business has its own website		1.00	0.077**	0.353**
Use a third-party website to promote or sell your goods or service			1.00	0.140**
Goods and services can be ordered directly from own website				1.00

Note: **Correlation is significant at the 0.01 level (2-tailed)

Appendix 2: Factor Anslysis Component Matrices Table 2A: Strategic Management Practices

	Component 1
Plans: Increase skills	0.739
Plans: Increase the leadership capability	0.739
Plans: Capital investment	0.559
Plans: Develop and launch new products or services	0.653
Plans: Introduce new working practices	0.693
Plans: Sell to new overseas markets	0.444

Notes: Extraction Method: Principal Component Analysis. One component extracted.

Table 2B: Management Capability

	Component 1
New people and management	0.582
Business plan and strategy	0.708
New product and service	0.509
External finance	0.502
Operational management	0.666
	· · · ·

Notes: Extraction Method: Principal Component Analysis. One component extracted.



Table 2C: Business Network

	Component 1	Component 1
A social media business network	0.617	0.103
A local Chamber of Commerce	0.567	-0.088
A formal business network	0.668	-0.106
An informal business network	0.605	0.110

Notes: Extraction Method: Principal Component Analysis. Two components extracted.

Table 2D: Training

	Component 1	Component 1
Leadership and management skills	0.789	-0.178
IT skills	0.363	0.489
Health and Safety	0.432	0.035
Technical, practical or job-specific skills	0.048	0.787
Teamworking skills	0.825	-0.068
	· · _	

Notes: Extraction Method: Principal Component Analysis. Two components extracted.

Table 2E: Business Support

	Component 1
Government support	0.555
Local enterprise partnership	0.785
Local growth hub support	0.778

Notes: Extraction Method: Principal Component Analysis. One component extracted.

Table 2F: Technology Intensity

	Component 1
Access to the internet for work purposes	0.481
Business has its own website	0.771
Use a third-party website to promote or sell your goods or service	0.360
Goods and services can be ordered directly from own website	0.738

Notes: Extraction Method: Principal Component Analysis. One component extracted.



Appendix 3: Residual plots

Model 1: Residual plots



Model 5: Residual Plots





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