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Management practices and SME performance

John Forth and Alex Bryson

Abstract

We examine the association between management practices and SME performance in Britain over the period 2011-2015, using a unique dataset which links survey data on management practices with firm performance data from the UK's official business register. We find that SMEs are less likely to use formal management practices than larger firms. However, such practices appear to have demonstrable benefits for those SMEs who use them, being positively associated with firm survival, growth and productivity. Our results add further weight to policy initiatives which seek to encourage SMEs to improve their management skills and capabilities.

Key Words: SMEs; small and medium-sized enterprises; employment growth; high-growth firms; productivity; workplace closure; management practices; HRM; recession.

JEL Codes: L25; L26; M12; M52; M53

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1. INTRODUCTION

Small and medium-sized enterprises (SMEs) have long been viewed as an important source of job creation and output growth (e.g. Birch, 1981; OECD, 2002; Hijzen *et al.*, 2010; Criscuolo *et al.*, 2014). Indeed, over 70 per cent of the growth in UK employment between 2010 and 2016 was located within SMEs; turnover in SMEs rose by almost one fifth over the same period (NESTA, 2017). However, as concerns about the UK's persistently weak productivity growth has deepened, attention has increasingly turned to small and medium-sized firms' over-representation within the long tail of low-productivity firms (Aradanaz-Badia *et al.*, 2017).

At the same time, a growing body of evidence has emerged to show that firms which engage in more extensive use of data collection and analysis, target setting and performance-focused human resource practices are more productive – and have higher levels of productivity growth – than firms with fewer of these formal management practices (see Bloom *et al.*, 2014, for one review). The evidence is particularly strong for manufacturing industries, where the majority of these recent studies have been located, but it is growing for service industries too (*ibid.*, pp.23-24).

Most of the accumulating evidence is, however, based on samples of medium-sized and large firms.¹ It is apparent from survey-based studies that smaller firms make less use of formal management practices (e.g. Forth *et al.*, 2006), but it is less clear whether such practices really benefit those that use them. One perspective sees practices such as target-setting, training and performance management as universally applicable, such that firms of all sizes should see positive returns from their implementation. Under this perspective, the lesser use of formal management practices among smaller firms might be attributed to a lack of knowledge about their benefits or greater difficulties in adopting new methods (Bloom *et al.*, 2011). An alternative perspective argues that small firms have distinctive characteristics which can make the extensive

use of formalised practices inappropriate (e.g. Kitching and Marlow, 2013). Greater use of such practices cannot then be expected to deliver performance benefits and may even be harmful.

We contribute to the literature by examining the association between management practices and firm performance among SMEs in Britain over the period 2011-2015, using a unique dataset which links high-quality survey data on management practices with longitudinal data on firm performance from the UK's official business register. This linked dataset provides us with detailed information about the internal organisation of the firm alongside longitudinal, accounting-type data on the firm's employment and sales. We find that SMEs are less likely to use formal management practices than larger firms. However, such practices appear to have demonstrable benefits for those SMEs who use them, being positively associated with firm survival, growth and productivity. The returns appear to be strongest for those investing in human resource management practices, such as rigorous recruitment and performance appraisal, and those setting formal performance targets.

Ours is the first study (that we are aware of) to investigate the association between formal management practices and firm performance among SMEs in Britain using a nationally representative sample which has longitudinal, accounts-type data on performance outcomes. Our results do not have a strict causal interpretation, but they extend the growing body of evidence on the benefits of formal management practices in large firms, suggesting that such practices also give positive returns among SMEs. The findings thus add further weight to policy initiatives which seek to encourage SMEs to improve their management skills and capabilities.

The paper proceeds as follows. Section Two reviews the existing literatures on the impact of management practices and discusses the potential for heterogeneity by firm size. Section Three introduces our linked data on management practices and firm performance, and outlines the methods used in our quantitative analysis. Section Four presents the results of our analysis of the prevalence of formal management practices among SMEs and of their association with SME

performance, based on the linked dataset. Section Five concludes and discusses some of the implications of the analysis.

2. THEORY AND PRIOR EVIDENCE

In recent years, there has been a growing interest in the potential benefits that may accrue to firms that make extensive use of ‘formal’ management practices. Motivated in part by a substantial body of evidence which documents persistent heterogeneity in the performance of firms, even within narrowly-defined industries, this literature has focused on the extent to which such heterogeneity may be explained by observable differences in firms’ use of operational and human resource practices (see, for example, MacDuffie, 1995; Ichniowski et al, 1997; Lazear, 2000; Black and Lynch, 2001; Bloom et al, 2016a; Brynjolfsson and McElheran, 2016a). Whilst the proposition that management matters is far from new, the development of datasets that link information on management practices with accounts-type data on firm performance has allowed this aspect of the firm to be subject to a greater degree of formal scrutiny.

One strand of research in this vein has focused primarily on human resource management (HRM) practices. Studies in this area have sought to investigate the contention that HRM practices can aid firm performance by: (a) helping the firm to acquire and develop its human capital; (b) structuring jobs in such a way as to encourage employee participation in process improvement; and (c) motivating employees to direct their efforts in line with organisational goals (see Bailey, 1993; Appelbaum et al, 2000). Research has thus focused on the performance effects of practices such as: recruitment tests and structured employee training; team-working and quality circles; and appraisal and incentive pay. Huselid (1995), for example, studied a cross-sectional sample of 1,000 US companies, finding that greater use of such HRM practices was associated with higher productivity (sales per employee) and better financial performance (Tobin’s q and gross rate of return on assets). Guest et al (2003) undertook a similar study of 366 UK companies with longitudinal data on firm performance; in their sample, an index of HRM

practices was positively associated with profitability (not productivity) but the association was non-significant after controlling for prior performance. A third study is that of Black and Lynch (2001), who analysed a sample of 636 US manufacturing establishments, again with longitudinal data on firm performance, finding that regular work-focused meetings and the use of profit-sharing schemes were positively associated with productivity, but other practices such as teamworking were not. The evidence from this strand of work on the performance benefits of HRM practices has thus been somewhat equivocal.

Another strand of research has focused primarily on operations management practices and performance incentives. The work of Bloom et al (2012, 2014, 2016a, 2016b) is prominent in this field. Building on discussions with management consultants and prior academic research, their work focuses on the performance effects of 18 practices under three broad headings: (a) performance monitoring (i.e. information collection and analysis); (b) target setting; and (c) people management (i.e. selection, development and performance-focused reward). The proposition is that those organisations which continuously monitor their processes, set comprehensive targets and pay close attention to the performance of their workforce will perform better than those which do not monitor their operations, have few targets and do little to address employee under-performance. Such management practices are thus viewed as being akin to a ‘technology’, in that they serve as an output-increasing factor of production (Bloom et al, 2016a). In a large, multi-country panel sample of manufacturing firms, greater use of such practices is associated with higher labour productivity, a lower probability of bankruptcy/closure, better stock market performance and faster sales growth (*ibid.*). Similar results have been obtained in single-country studies of manufacturing firms that focus on the same set of practices: see Bloom et al (2017) and Brynjolfsson and McElheran (2016a) for evidence from the USA, and Broszeit et al (2016) for evidence from Germany. There is also similar evidence for the service sector, with studies showing positive returns from the more extensive use of formal management

practices in education (Bloom et al, 2015) and healthcare (Bloom et al, 2014: 24). Efforts to break down the management index in such studies have been somewhat limited, though Brynjolfsson and McElheran (2016a) find that there are specific returns from the intensive collection and use of performance-related data, while Broszeit et al (2016) find returns from the more intensive use of monitoring and incentives, but not from the more intensive use of performance targets.

One general feature of all of these studies, and of many others which map the incidence of formal management practices (e.g. Forth et al, 2006; Wu et al, 2015), is that smaller firms tend to be less extensive users of such operational and human resource management practices than larger firms. There may be a variety of reasons for this. Evidence suggests that SMEs find it more difficult than larger firms to identify and adopt innovative technologies and working methods due to their weaker internal resources (Roper and Hart, 2013), with research focusing in particular on the lower (average) levels of managerial human capital and employee human capital in smaller firms, and the lesser involvement of SMEs in managerial networks (see Bloom et al, 2011; Wu et al, 2015). To the extent that SMEs are more likely to operate in smaller, more-localised markets, this may also hold back the pursuit of ‘best practice’ by limiting the incentivising effects of competition (on the general effects of competition, see Bloom et al, 2011; Bloom et al, 2017). Under this perspective, if the returns to such practices are indeed universal, then the less extensive use of formal management practices among smaller firms may be seen as sub-optimal.

However, an alternative perspective points to the possibility of heterogeneity by firm size in the returns to such practices, indicating that formal practices may be inappropriate, and possibly even harmful, to SMEs (Kitching and Marlow, 2013). Such a scenario may arise if there are economies of scale in the adoption of data-driven management practices relying on information technology (as suggested by Brynjolfsson and McElheran, 2016b), or scale economies in the

development of employee appraisal systems and off-the-job training programs (as suggested by De Grip and Sieben, 2009). It may also arise if the close networks that exist between managers and employees in small firms allow such firms to share information and knowledge without the costs of formalisation.

Broszeit et al (2016) explicitly investigate the impact of formal management practices on SME performance, finding that such practices have a positive effect, but one which is weaker than that found among larger firms. There are, however, to our knowledge no studies of SMEs in Britain which link data on management practices with accounts-type data on firm performance to permit a similar investigation. Those studies which do exist have used subjective ratings of performance provided by the same respondents who report on the firm's use of management practices. Wu et al (2015), Lai et al (2016) and Sheehan (2014) all find positive associations between the use of formal management practices and performance among SMEs. However, the nature of the performance measures means that each study is open to concerns about common-method bias.ⁱⁱ

We contribute to the literature by examining the association between management practices and firm performance among SMEs in Britain over the period 2011-2015, using a unique dataset which links high-quality survey data on management practices with longitudinal data on firm performance from the UK's official business register. We first examine the extent to which formal management practices are used among SMEs, and the factors that are associated with greater use. We then go on to look at the association between the use of such management practices and firm survival, growth and productivity.

3. DATA AND METHODS

Data:

Our analyses are based on data from the 2011 Workplace Employment Relations Survey (WERS) (Department for Business Innovation and Skills et al, 2014) and the Business Structure

Database (BSD) (Office for National Statistics, 2015). WERS is a linked employer-employee survey which provides nationally representative data on workplaces in Britain with five or more employees. The strength of the survey lies in the richness of data collected on workplace policies and practices. The 2011 WERS was undertaken between February 2011 and June 2012 via face-to-face interviews with managers responsible for employment relations at the workplace. The WERS survey included a Financial Performance Questionnaire, but responses were received from relatively few workplaces, meaning that accounting-type data on firm performance must be sought from elsewhere. We link part of the sample (see below) to the Business Structure Database, taking advantage of the fact that both sources ultimately trace back to the Inter-Departmental Business Register (IDBR) – the UK’s official register of businesses and the sampling frame for official surveys of business activity.

The 2011 WERS comprised two elements: a panel sample of around 1,000 workplaces and a refreshment sample of around 1,700 workplaces. The panel sample consisted of around 1,000 workplaces which had each been interviewed in the previous wave of the survey in 2004. This part of the 2011 sample cannot effectively be linked to the BSD as it lacks up-to-date IDBR reference numbers, having been originally sampled in 2003.ⁱⁱⁱ However, the refreshment sample was drawn (using stratified random sampling) from the IDBR in September 2010. In 92% of these refreshment sample workplaces, the managerial respondent to WERS gave permission for their survey data to be linked to other research datasets and, in these cases, an up-to-date (2010) IDBR enterprise reference number is provided with the dataset to allow one to link the workplace data to other business datasets which also trace back to the Register. We focus on the private sector workplaces within this linkable sub-sample, of which there are 1,073. Sampling weights are provided which make this WERS sample representative of all private sector workplaces in Britain with five or more employees, with the exception of those in agriculture and mining which are excluded from the survey. Among our sample of 1,073 workplaces, 343 belong

to small firms (those with 5-49 employees), 182 belong to medium-sized firms (50-249 employees) and 548 belong to large firms (250 or more employees). When weighted to be representative of the population, 57% of the sample are small firms, 11% are medium-sized firms and 32% are large firms.

The BSD comprises annual ‘snapshots’ taken from the IDBR and contains records on all firms with turnover above the VAT threshold and all firms with PAYE schemes (a total of over 2 million firms).^{iv} Firm-level records in the BSD are linked over time via their unique IDBR enterprise reference number so the database provides a dynamic view of firm entry, exit and growth. The number of variables found in the BSD is small relative to other data sources, but it contains data on employment and turnover, taken from VAT and PAYE records. The strength of the database therefore lies in its comprehensive coverage of all but the very smallest firms in the UK economy; this means that we can expect a very high match rate with the WERS sample described above. Indeed, the comprehensive coverage of the BSD gives it a considerable advantage in SME analysis over the more-detailed Annual Business Survey, which samples less than one-tenth of small firms and follows each sampled firm for only two years.^v

We use the IDBR enterprise reference number to link the WERS 2011 refreshment sample workplaces to their appropriate firm-level records in the BSD. It is then possible to use the longitudinal administrative data contained within the BSD to measure the performance of the firm from 2011 onwards, whilst also controlling for its rate of growth prior to 2011. We can then use the linked BSD-WERS sample to explore the characteristics associated with firm performance in a way that has not previously been possible in Britain. We are thus able to generate unique and valuable insights into the factors associated with survival, growth and productivity among a nationally-representative sample of SMEs.

In trying to explain the role of workplace practices on SME performance, we use the surveyed WERS workplace to characterise the whole of the firm, even though the firm may have other

workplaces that are unobserved in our sample and which might differ from the surveyed workplace. In practice, the degree of such measurement error is likely to be small, at least among SMEs. If we compare the employment numbers recorded for the workplace in WERS with those recorded for the whole firm in the BSD, we find that the WERS workplace accounts for 95% of the firm’s total employment on average within our SME sample (see Table 1 below). For workplaces belonging to firms with 5-49 employees, the average is 100% and for those with 50-249 employees it is 85%; by comparison, the average for workplaces belonging to firms with at least 250 employees is just 39%.^{vi} Consequently we do not attempt a specific investigation of the performance effects of management practices in large firms using the linked WERS-BSD sample. We do provide some results for the full sample (SMEs and large firms combined), for comparison with the results from our SME sample, but SMEs remain the focus of our discussion.

In those analyses which are presented, we include a control for the share of total firm employment that is accounted for by the WERS workplace. We also cluster our standard errors to account for the intra-class correlation that is likely to exist between workplaces that have siblings in the sample from the same large firm (a situation which applies to around one fifth of the workplaces belonging to large firms).^{vii}

Table 1: Share of enterprise employment accounted for by the sampled WERS workplace

	Mean	Median
Small firm	100%	100%
Medium-sized firm	85%	70%
Large firm	39%	5%
All SMEs	95%	90%
All firms	66%	48%

Source: WERS-BSD linked sample. Unweighted.

Measuring management practices

In measuring management practices, we take our cue from the various strands of literature summarized earlier in the paper (pp. 5-6). These literatures overlap to some degree and so we develop a schema which organizes the practices into three main groups. The first group comprises 'human resource' practices covering recruitment, training, appraisal and incentive pay. These management practices are focused around ensuring that employees have the knowledge and skills required by the organisation, and that they are motivated to contribute towards organisational success (the 'ability' and 'motivation' elements of the Ability-Motivation-Opportunity (AMO) framework (Appelbaum et al, 2000), which is a common reference point in the HRM-performance literature). The second group comprises practices relating to the organisation of work within the firm, specifically covering the use of semi-autonomous teamworking, employee involvement in problem-solving and just-in-time processes. The first two practices in this set are focused around ensuring that employees have the opportunity to deploy their skills and tacit knowledge effectively (the final part of the AMO framework), whilst the use of just-in-time processes reflects efficiency concerns that are prominent in the operations management literature. The final group focuses on the use of organisational performance targets. The use of such targets helps managers to be informed about whether the organisation is performing appropriately: alerting them to potential problems and to the need for appropriate actions. The use of such performance targets is a key part of the emerging literature on data-driven management practices (Brynjofsson and McElheran, 2016a, 2016b).

The full list of practices captured in our index is presented below. Descriptive statistics showing the incidence of each practice in our unweighted sample can be found in Appendix A.

Human resource practices: Performance tests used in recruitment for the largest occupational group; Performance appraisals for at least 80% of the largest occupational group; Any off-the-job training given to the largest occupational group (excluding health and safety training); Any

performance-related pay (merit pay, payment-by-results, profit-sharing or share-ownership) for any group of employees.

Work organization: Use of teamworking arrangements where team members jointly decide how work is to be done; Use of problem-solving groups or quality circles; Just-in-time methods of production or service delivery.

Target setting: Whether targets are set for: Volume of goods produced/services delivered; Total costs; Profits/return on investment; Unit labour costs; Productivity; Quality of product or service.

Our primary index of management practices comprises a simple count of these practices, hypothetically ranging from 0 to 13. To examine the incidence and effects of its components, we also divide the index into its three constituent parts, compiling indices for the number of human resource practices (ranging 0-4), the number of work organization practices (0-3) and the number of production targets (0-6).

Descriptive statistics for our survey population are shown below. Among SMEs, the mean number of management practices is 5.19 (out of 13), with a standard deviation of 2.88. A comparison between small, medium-sized and large firms indicates that the use of formal management practices is positively correlated with firm size, although the correlation is weaker for the count of work organization practices than for the counts of HR practices and production targets.

Table 2: Mean number of management practices, and standard deviations, by firm size

	Small		Medium		Large		All SMEs		All firms	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Full index (MN)	4.90	2.83	6.75	2.68	7.64	2.51	5.19	2.88	5.97	2.99
Index of HR practices (M_HR)	1.97	1.26	2.70	1.07	2.92	0.95	2.09	1.26	2.35	1.23
Index of Work organisation (M_WK)	0.80	0.73	0.90	0.87	0.89	0.84	0.81	0.76	0.84	0.78
Index of Targets (M_TARG)	2.13	2.00	3.15	1.80	3.83	1.76	2.29	2.00	2.78	2.06
<i>Unweighted N</i>	<i>335</i>		<i>178</i>		<i>520</i>		<i>513</i>		<i>1033</i>	

Source: WERS-BSD linked sample. Mean values computed using survey weights.

When utilizing these measures of management practices in regression analysis, we standardize the full index, giving it a mean of 0 and a standard deviation of 1. We take the same approach for the three sub-indices and, when these are used, we also include a dummy variable which identifies workplaces that are above the mean on all three sub-components.

Measuring firm performance

We utilize a variety of measures of firm performance. First, we look at the probability that a firm remains in the population (i.e. does not close down). This can perhaps be thought of as the strictest test of the efficacy of formal management practices: are they associated with an increased probability of firm survival in the medium-term? Second, we look at rates of firm growth. The BSD allows us to measure growth in employment and total sales. The recent UK literature on high-growth firms tends to focus primarily on employment growth (e.g. Anyadike-Danes et al, 2009; Hijzen et al, 2010), but we follow the official statistics on business demography (e.g. Eurostat-OECD, 2007) in looking at growth in employment *and* total sales. This recognises that, whilst job creation is an important social and economic outcome, firms are likely to have growth objectives focused around revenue, since sales ultimately indicate market success. We focus on growth in employment and growth in turnover separately. However, we

also analyse a binary variable which identifies those firms that meet the Eurostat-OECD definition of ‘high-growth’, that is: growth of at least 20 per cent per annum on either measure). Our third and final performance measure is productivity growth, which is the conventional measure of efficiency.

In order to analyse these performance outcomes, we observe firms over three periods: 2011-2013 (a two-year follow-up); 2011-2014 (three years); and 2011-15 (four years). The choice of a variety of follow-up periods reflects a tension between the desire to keep the time period for measuring performance outcomes reasonably close to the time point for measuring management practices, in case practices change over the intervening period, and the desire to have a reasonable observation window over which performance outcomes can play out. The former would imply a shorter follow-up period; the latter a longer follow-up. Our preference is three years, but we include two and four-year follow-ups to show the sensitivity of our results to this choice.

Our various measures of performance are thus defined as follows:

Firm exit (death): A binary variable (0/1) indicating whether the firm ceased to trade at any point between 2011 and year t (where $t=2013, 2014$ or 2015). This is identified using the ‘date of death’ on the BSD, which marks the date on which the firm ceased trading.^{viii} Following Welpton (2009), this measure of exit is preferred to one which simply traces the year that a firm leaves the BSD panel, since firms can remain on the register for some years following cessation of trading.

Employment growth: Measured as the log change in the firm’s employment between 2011 and year t , i.e. $\ln(E_t/E_{2011})$

Turnover growth: Measured as the log change in the firm’s gross sales (turnover) between 2011 and 2014, i.e. $\ln(T_t/T_{2011})$

High-growth firm: A dummy variable equal to 1 if the firm posted average growth of 20%+ per annum in either employment or turnover over the period between 2011 and year t .

Productivity growth: Measured as the log change in the firm's labour productivity between 2011 and year t , i.e. $\ln(LP_t/LP_{2011})$, where labour productivity is measured as turnover per employee (T/E) .^{ix}

Analytical approach:

In our analysis of the use of management practices, we use OLS regressions to estimate the probability that a firm is using a more extensive array of formal management practices. These analyses regress the full, standardized index of management practices on a measure of firm size, along with a set of firm characteristics shown to be informative in the previous literature, including firm ownership, internationalization and product market competition, plus standard firm-level controls such as industry and region.

Our regression analyses of survival/exit use a probit estimator to analyse the relationship between management practices present in 2011 and the probability of exit over the subsequent period, after controlling for a variety of other firm characteristics, including its level of financial performance, all collected in 2011.^x The coefficients are presented in terms of marginal effects.

Our measures of employment growth, turnover growth, high-growth and productivity growth are, necessarily, observed only for the subset of firms that survived (i.e. the subset for which $exit=0$). Among these surviving firms, we use OLS regressions to analyse the relationship between management practices and employment growth, turnover growth and productivity growth, and a probit estimator to analyse the relationship between management practices and the probability of being a high-growth firm (with the probit coefficients again presented as marginal effects). We measure performance in the three years prior to the WERS survey (2008-2011) and use this 'prior trajectory' as a control variable in our regression analyses, alongside a set of firm

characteristics.^{xi} We also compute the inverse Mills ratio (IMR) from the probit regression of firm exit and include this ‘hazard rate’ among the covariates of each performance regression in an attempt to correct for any upward bias that may result from focusing only on survivors. The variable omitted from the regressions of firm performance is the WERS respondent’s subjective assessment of the workplace’s financial performance relative to others in its industry sector in 2011, which previous studies have found to be a strong predictor of workplace closure (e.g. Machin, 1995) and which is statistically significant in our exit regression.^{xii}

Analyses are weighted by the WERS workplace sampling weights so that they reflect figures for the population from which they were sampled, rather than merely within-sample estimates. Standard errors account for the use of variable probability sampling in the survey design and (as noted earlier) for the inclusion of multiple workplaces from some large firms.

Although our data include indicators of many potential drivers of firm performance, they do not include some drivers that are argued to be important in the literature. One such is access to credit, which became more difficult for SMEs in the aftermath of the financial crisis, albeit without clear evidence of a depressing effect on productivity (Riley et al, 2014). Another absentee is a measure of firms’ growth ambitions, although the available evidence suggests that these are not strongly predictive of actual growth outcomes once other characteristics are controlled for (Department for Business Innovation and Skills, 2016). Despite these omissions, our range of firm characteristics is wider than is typically available.

Our study is still limited, however, by our inability to make causal inferences about the link between management practices and firm performance. We are able to account for the performance trajectories of firms prior to 2011, so that the comparisons we make partial out the potentially confounding dynamic effects that might otherwise bias our estimates of the links between practices and performance. But we are unable to account for the fact that a firm’s

choice of management practices may partly be based on its performance trajectory and thus endogenous.

4. RESULTS

The presentation of results proceeds in two parts. First, we present analyses of the types of firm that use formal management practices, showing the variation by firm size and also the correlation with other firm characteristics, such as the type of owner. We then go on to present analyses of the association between the use of management practices and our chosen measures of firm performance. In each case, our primary focus is on the sample of SME firms. We also discuss some results from the wider sample that additionally includes larger firms (those with 250+ employees) for comparison. However, we are less confident to draw firm conclusions from that sample about the link between management practices and performance because the units of observation for management practices and firm performance diverge to a greater extent among larger firms (see Table 1).

Which firms use formal management practices?

Table 3 reports an OLS regression analysis which identifies the workplace and firm characteristics that are associated with greater use of our chosen set of formal management practices. Column 1 presents the results for our sample of SMEs, whereas column 2 presents the results for the sample of all firms.

Many of the results shown in Table 3 are in line with expectations. In keeping with the existing literature (e.g. Forth et al, 2006; Wu et al, 2015) – and in line with the bivariate analysis presented in Table 2 – we find that the use of formal management practices increases monotonically with firm size. However, the gradient is not steep. After controlling for other factors, the average number of practices used by medium-size firms (those with 100-249 employees) is around three-

quarters of a standard deviation (0.769) higher than the number used by micro firms (those with 5-24 employees) (Table 3, column 1). This equates to an average difference of 2.2 practices.

Table 3: OLS regression of the number of formal management practices in use

	SMEs	All firms
<i>Organisation size:</i>		
5-24 employees	Ref. [.]	Ref. [.]
25-49	0.409*** [3.47]	0.343*** [2.94]
50-99	0.488*** [2.79]	0.437*** [2.73]
100-249	0.769*** [5.29]	0.673*** [4.71]
250+		0.938*** [7.16]
<i>Year firm started:</i>		
2006-2010	0.134 [0.82]	0.093 [0.59]
2001-2005	0.059 [0.45]	0.031 [0.26]
1996-2000	0.248 [1.58]	0.229 [1.61]
Pre 1996	Ref. [.]	Ref. [.]
<i>Largest occupational group:</i>		
Professionals	0.538* [1.94]	0.574** [2.57]
Associate professionals	0.222 [0.79]	0.264 [1.16]
Administrative	0.033 [0.12]	0.056 [0.26]
Skilled Trades	0.222 [0.80]	0.247 [1.06]
Caring and leisure	0.389 [1.41]	0.34 [1.57]
Sales and customer service	0.38 [1.56]	0.408** [2.28]
Process, plant and machine operators	-0.271 [-0.87]	-0.192 [-0.75]
Elementary occupations	Ref. [.]	Ref. [.]

continued...

Table 3 continued

	SMEs	All firms
Owner-manager	-0.016 [-0.21]	-0.007 [-0.13]
Foreign-owned	0.372* [1.89]	0.261** [2.21]
Main market is international	0.480*** [3.56]	0.491*** [4.00]
<i>Degree of market competition:</i>		
High/Very high	Ref. [.]	Ref. [.]
Neither high nor low	-0.08 [-0.64]	-0.013 [-0.11]
Low/Very low	-0.266* [-1.64]	-0.157 [-1.20]
Count of employer networks	0.147*** [2.66]	0.172*** [4.19]
Unions recognised	0.26 [1.44]	0.342*** [2.94]
Constant	-0.745* [-1.95]	-0.628** [-2.00]
Industry dummies	Yes	Yes
Region dummies	Yes	Yes
N	499	983
adj. R-sq	0.232	0.315

Notes:

1. t statistics in brackets
2. p<0.10, ** p<0.05, *** p<0.01
3. Regressions include seven industry dummies (SIC(2003) Sections D-F, G, H, I-K, M, N, O) and 11 region dummies (Government Office Regions)

Source: WERS-BSD linked sample

There is no statistically-significant association with firm age. However, firms in which the largest occupational group are Professionals use the highest number of management practices, on average. This is in line with prior evidence which suggests that the adoption of formal management practices is more extensive in firms with higher levels of employee human capital (Bloom et al, 2012, 2017). Turning to firm ownership characteristics, firms with an owner-manager do not differ in the number of management practices from those where the roles of owner and manager are separated. Owner-managed firms exhibited particularly low use of formal

management practices in Bloom et al.'s original work (Bloom et al., 2012), leading them to suggest that family ownership may depress managerial quality by reducing the pool of available managerial recruits. However, an indicator of family-ownership is non-significant in Broszeit's multivariate analysis for Germany (Broszeit et al, 2016), and so the evidence is mixed on the importance of owner-management. The evidence is more consistent on the importance of internationalization and competition, however. In line with Bloom et al (2012) and Broszeit et al (2016), we find that foreign-owned firms and those who operate in international product markets are more extensive users of formal management practices. We also find that greater levels of product market competition are positively associated with the use of formal management practices: a relationship which Bloom et al (2017) have plausibly shown to be causal.

Wu et al (2014) have previously shown that extensive use of management practices is more likely when the firm is embedded in a larger array of employer networks, and we replicate this result here. Our analysis counts the number of different types of membership association to which the firm belongs (a 0-5 count variable, based on membership of: an employers' association; an industry or trade associations; a Chamber of Commerce; the Federation of Small Business; or some other similar group), and finds a positive and statistically significant association between this count variable and the number of management practices in use. Each additional network raises the number of management practices in use by around 0.15 standard deviations (or 0.4 practices), on average.

Finally, the presence of recognized trade unions is positively associated with the number of management practices, but the association is only statistically significant in the full sample of all firms. The positive and statistically significant association for all firms stands against the non-significant association between works councils and management practices in Germany (see Broszeit et al., 2016) but British unions and German works councils are rather different in form and function; our result is in line with recent research in Britain which shows that unionized

firms are more extensive users of high-involvement management practices (Askenazy and Forth, 2016).

Is the use of formal management practices associated with better firm performance?

Table 4 reports the results of the first in a series of regression analyses in which we investigate whether firms that have more extensive use of formal management practices have superior performance to less extensive users. In this first set of results, we employ a parsimonious specification in which we control for a limited set of firm demographics (industry, region and age), alongside the controls for the firm's prior performance trajectory. The set of controls is extended in subsequent specifications presented in Table 5. In both tables, the first panel presents results for the two-year follow-up period (2011-13), with results for the three and four-year follow-up periods presented below. A full set of coefficients for our preferred follow-up period (2011-14) are presented in Appendix B.

Column 1 of each table shows the marginal effect of a one standard deviation increase in the management index on the probability that a firm exits the population (closes down) over the follow-up period. As noted earlier, this is a strict test. Bloom et al (2016a, 2017) find, in their samples of manufacturing plants, that firms using more management practices are less likely to close down. In our parsimonious specification (Table 4), we find a negative and statistically significant correlation with the probability of firm closure in all three periods. The magnitude of all three coefficients falls as we enter additional control variables (see Table 5), but a statistically significant negative association remains in two of the three periods (2011-13 and 2011-15). The coefficient of -0.031 for 2011-13 implies that a one standard deviation increase in the management index (equivalent to an increase of 2.88 practices – see Table 2) is associated with a fall of 3 percentage points in the probability of SME exit over this period. Around one in ten SMEs exit the population over this period and so, if causality could be established, this would represent a considerable impact.

Table 4: Management index and SME performance: parsimonious specification

	p(Exit) Probit (dy/dx)	Ln(employment growth) OLS	Ln(turnover growth) OLS	p(High- growth) Probit (dy/dx)	Ln(productivity growth) OLS
2011-2013:					
Index of management practices	-0.034* [-1.82]	0.020 [0.73]	0.053* [1.88]	0.051* [1.83]	0.065** [2.14]
<i>Num. obs.</i>	497	445	445	445	445
<i>Goodness of fit</i>	0.23	0.04	0.07	0.11	
2011-2014:					
Index of management practices	-0.039* [-1.84]	0.005 [0.13]	0.035 [0.86]	0.059*** [2.77]	0.068** [2.31]
<i>Num. obs.</i>	497	428	428	428	428
<i>Goodness of fit</i>	0.12	0.05	0.03	0.19	0.15
2011-2015:					
Index of management practices	-0.057** [-2.57]	-0.009 [-0.21]	0.046 [0.78]	0.047** [2.34]	0.079** [2.27]
<i>Num. obs.</i>	497	417	417	417	417
<i>Goodness of fit</i>	0.11	0.05	0.04	0.28	0.25

Notes:

1. Probit coefficients are expressed as marginal effects
2. t statistics in brackets; p<0.10, ** p<0.05, *** p<0.01
3. Control variables: industry sector; region; year firm started; prior growth in employment (column 2); prior growth in turnover (columns 3 and 4); prior growth in productivity and level of productivity (column 5)
4. Goodness of fit: probits = pseudo r-squared; OLS = adjusted r-squared.

Source: WERS-BSD linked sample

Table 5: Management index and SME performance: full specification

	p(Exit) Probit (dy/dx)	Ln(employment growth) OLS	Ln(turnover growth) OLS	p(High- growth) Probit (dy/dx)	Ln(productivity growth) OLS
2011-2013:					
Index of management practices	-0.031** [-1.96]	0.005 [0.18]	0.036 [1.16]	0.025 [1.06]	0.052 [1.57]
<i>Num obs.</i>	497	445	445	445	445
<i>Goodness of fit</i>	0.38	0.15	0.12	0.26	0.17
2011-2014:					
Index of management practices	-0.025 [-1.25]	0.014 [-0.39]	0.017 [0.40]	0.036* [1.78]	0.054* [1.72]
<i>Num obs.</i>	497	428	428	428	428
<i>Goodness of fit</i>	0.26	0.19	0.06	0.35	0.21
2011-2015:					
Index of management practices	-0.038* [-1.76]	-0.025 [-0.60]	0.031 [0.54]	0.027 [1.53]	0.054 [1.55]
<i>Num obs.</i>	497	417	417	417	417
<i>Goodness of fit</i>	0.21	0.24	0.08	0.43	0.33

Notes:

1. Probit coefficients are expressed as marginal effects
2. t statistics in brackets; p<0.10, ** p<0.05, *** p<0.01
3. Control variables: see Appendix B for full list.
4. Goodness of fit: probits = pseudo r-squared; OLS = adjusted r-squared.

Source: WERS-BSD linked sample

Columns 2 and 3 of the tables show the association between a one standard deviation increase in the management index and the rate of growth in employment and turnover respectively. Again, our coefficients have the same sign as in the studies of Bloom et al (2016a, 2017) but, here, with only one exception, they are statistically non-significant across both the parsimonious and full specifications. Greater use of management practices cannot therefore be said to be associated with faster rates of firm growth, on average, within our SME sample. However, the index does appear to have some traction in the upper tail of the growth distribution. Specifically, column 4 of Table 4 shows that a one standard deviation increase in the management practices index is associated with an increase of approximately 5 percentage points in the probability of a firm registering 'high-growth' (defined as a growth rate of at least 20% per annum in either employment or turnover over a period of three years). Again, the coefficients are smaller under the full specification, falling to around 3 percentage points, but the coefficient in our preferred follow-up period (2011-14) remains statistically significant from zero at the 10 per cent level.

Finally, in column 5, we investigate the association between our index of management practices and firm productivity growth. The studies of Bloom et al (2016a, 2017) and Broszeit (2016) each show positive and statistically significant associations between the greater use of formal management practices and productivity. We also find some evidence of this in our sample of SMEs. In the parsimonious specification, there is a positive and statistically significant association in all three follow-up periods. The association remains statistically significant in our preferred period under the full specification, where a one standard deviation increase in our index of management practices is associated with a 5% increase in the growth rate of firm productivity. The coefficients for the adjacent periods are of a very similar magnitude but fall just short of statistical significance at the 10 per cent level.^{xiii}

The results for the various performance metrics therefore vary depending on the period of observation, but we find a statistically significant, positive association between management

practices and firm survival in two of our three follow-up periods (2011-13 and 2011-15) and a statistically significant, positive association with firm growth and productivity in our preferred period (2011-14).

These associations with firm growth and productivity are robust to sample selection caused by firm exit. In our full specifications, we compute the inverse Mills ratio (IMR) from the probit regression of firm exit and include this 'hazard rate' among the covariates for the subsequent performance metrics, in order to correct for any upward bias that may result from focusing only on survivors. The coefficient on the IMR term is typically negative, as we would expect, indicating that those firm characteristics which are associated with a higher probability of exit are also associated with lower levels of performance among survivors. However, the term only reaches statistical significance in the employment growth regressions.

We do not dedicate much discussion to the results for the full sample of firms (SMEs plus large firms), for the reasons outlined earlier. However, when we apply the full specification for the 2011-14 follow-up period to the complete sample of firms, we find that the results for this larger sample are qualitatively similar to those for SMEs. There is a suggestion that the association between the management practices index and the probability of 'high-growth' is slightly weaker in this sample ($\beta=0.031$; $t=2.03$), and the association with productivity growth slightly stronger ($\beta=0.064$; $t=2.55$), but the differences are relatively small. Detailed results are presented in Appendix C.

As noted earlier, the full index of management practices is based on a total of 13 practices, which can be conceptually divided into three sub-indices: human resource practices; work organisation; and target setting. We explore the relative importance of these different components by creating a standardized score for each of the three sub-indices and entering these into the full specification for our preferred period (2011-14) in place of the full index. The results are presented in Table 6.^{xiv} We find that the index of HR practices (measuring the use of recruitment

tests, off-the-job training, performance appraisal and incentive pay) is significantly associated with turnover growth and the probability of being a high-growth firm.^{xv} The HR index is also positively associated with productivity, but the coefficient falls just short of statistical significance at the 10 per cent level. The index of work organisation is not significantly associated with any measure of firm performance, whereas the index of target setting is positively and significantly associated with labour productivity growth.^{xvi} This pattern of results differs somewhat from that shown by Broszeit et al (2016), who find that their index of HR practices and monitoring practices are more strongly associated with productivity than their index of target setting. However, direct comparisons between the two studies are made difficult by the lack of a complete overlap in the practices captured by their respective survey instruments.

Table 6: Management practices (sub-indices) and SME performance, 2011-14

	p(exit) Probit (dy/dx)	Ln(employment growth) OLS	Ln(turnover growth) OLS	p(High- growth) Probit (dy/dx)	Ln(productivity growth) OLS
SMEs:					
Index of HR practices	-0.010 [-0.48]	0.054 [1.50]	0.080* [1.86]	0.073*** [3.85]	0.055 [1.56]
Index of work organisation	0.016 [0.94]	-0.059 [-1.40]	-0.074 [-1.33]	-0.011 [-0.58]	0.008 [0.26]
Index of target setting	-0.016 [-0.77]	-0.045 [-1.15]	0.014 [0.31]	0.005 [0.21]	0.062** [2.01]
Above average on all three indices	-0.068 [-1.07]	0.101 [0.79]	-0.021 [-0.13]	-0.015 [-0.27]	-0.161 [-1.55]
Num. obs.	497	428	428	428	428
Goodness of fit	0.27	0.20	0.07	0.37	0.22

Notes:

1. Probit coefficients expressed as marginal effects
2. t statistics in brackets; p<0.10, ** p<0.05, *** p<0.01
3. Control variables: see Appendix B for full list
4. Goodness of fit: probits = pseudo r-squared; OLS = adjusted r-squared.

Source: WERS-BSD linked sample

5. DISCUSSION AND CONCLUSIONS

Researchers and policy makers have long recognised the contribution that SMEs make to job creation and output growth. However, as the search goes on to understand more fully the causes of the UK's weak productivity growth, attention has increasingly turned to the long tail of low-productivity firms, where smaller firms are over-represented.

Those seeking to explain firm-level heterogeneity in productivity (and other measures of firm performance), have long suspected that such variance may be explained by observable differences in firms' use of operational and human resource practices. With the development of datasets that link quantitative measures of a range of management practices to accounts-type data on firm performance, this question has become the subject of considerable research activity. Building partly on earlier contributions from researchers in the field of HRM, economists are now collating a considerable body of evidence which shows that firms which engage in more extensive use of data collection and analysis, target setting and performance-focused human resource practices perform better than firms with fewer of these formal management practices. Yet much of this evidence is based on samples of medium-sized and large firms, with few studies (either from HRM or economics) seeking to explicitly investigate the returns to formal management practices among SMEs. This is an important omission, since some have suggested that the use of formalised practices may be inappropriate and counterproductive in smaller firms.

We examine the association between management practices and SME performance in Britain over the period 2011-2015, using a unique dataset which links survey data on management practices with firm performance data from the UK's official business register. We find that SMEs are less likely to use formal management practices than larger firms, even after controlling for a range of other factors. Nevertheless, such practices appear to have demonstrable benefits

for the SMEs that use them. Results vary depending on period of observation, but we find a statistically significant, positive association between management practices and firm survival in two of our three follow-up periods, and a statistically significant, positive association with firm growth and productivity in our preferred period (2011-14). When we break down the overall management index into its sub-components for this period, human resource practices, such as recruitment tests and performance appraisal, have the strongest association with the probability of being 'high-growth', whilst target setting practices (specifically those focused on productivity and profits) have the strongest association with growth in labour productivity.

Our linked data are limited somewhat by the absence of longitudinal information on management practices. Instead, we are only able to observe the association between the management practices that firms have in place in 2011 and their performance over the subsequent 2-4 years (2011-13, 2011-14 and 2011-15). We also lack any formal means of identification, and so we are unable to say definitively that the associations seen here are causal. However, our study has an advantage over all previous studies for Britain in being able to call upon a nationally-representative sample of SMEs which can be linked to longitudinal, accounts-type data on firm performance. Our results are broadly in line with other quasi-experimental and experimental evidence which points to a causal link between the more extensive use of formal management practices and firm performance (see Bloom et al, 2017).

Our results thus extend the growing body of evidence on the benefits of formal management practices in large firms and add further weight to policy initiatives which seek to encourage SMEs to improve their management skills and capabilities.

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6. APPENDIX A: DESCRIPTIVE STATISTICS (UNWEIGHTED)

	All firms			SMEs			Continuous?
	N	mean	SD	N	mean	SD	
Management index (0-13)	1,007	7.10	3.00	499	5.87	2.89	Y
Sub-index: Training and incentives	1,007	2.72	1.12	499	2.34	1.20	Y
Performance tests	1,007	0.51	0.50	499	0.38	0.49	
Performance-related pay	1,007	0.66	0.47	499	0.60	0.49	
Performance appraisals	1,007	0.71	0.45	499	0.62	0.49	
Off-the-job training	1,007	0.84	0.37	499	0.74	0.44	
Sub-index: Work organisation	1,007	1.06	0.87	499	0.89	0.82	Y
Teamworking	1,007	0.28	0.45	499	0.25	0.44	
Problem-solving groups	1,007	0.25	0.43	499	0.15	0.36	
Just-in-time approach	1,007	0.52	0.50	499	0.48	0.50	
Sub-index: Targets	1,007	3.33	2.04	499	2.65	2.03	Y
Volume of goods/services produced	1,007	0.70	0.46	499	0.63	0.48	
Total costs	1,007	0.62	0.49	499	0.49	0.50	
Profits/return on investment	1,007	0.59	0.49	499	0.50	0.50	
Unit labour costs	1,007	0.40	0.49	499	0.28	0.45	
Productivity	1,007	0.46	0.50	499	0.34	0.48	
Quality of product/service	1,007	0.56	0.50	499	0.39	0.49	
Firm exited 2011-2014	1007	0.06	0.24	499	0.11	0.31	
Ln(employment growth 2011-2014)	937	-0.05	0.56	463	-0.05	0.60	Y
Ln(employment growth 2008-2011)	950	0.26	0.65	458	0.33	0.68	Y
Ln(Turnover growth 2011-2014)	939	0.07	0.72	463	0.03	0.77	Y
Ln(Turnover growth 2008-2011)	951	0.24	0.79	459	0.21	0.82	Y
High-growth firm	937	0.13	0.34	463	0.17	0.37	
Ln(Labour productivity growth 2011-2014)	937	0.13	0.63	463	0.10	0.71	Y
Ln(Labour productivity growth 2008-2011)	950	-0.04	0.77	458	-0.13	0.79	Y
Ln(Labour productivity in 2011)	1,005	4.11	1.25	497	4.02	1.12	Y
<i>Financial performance:</i>							
A lot better than average	1,007	0.12	0.33	499	0.10	0.30	
Better than average	1,007	0.40	0.49	499	0.38	0.49	
About average	1,007	0.37	0.48	499	0.40	0.49	
Below average/A lot below average	1,007	0.07	0.26	499	0.06	0.25	
No comparison possible	1,007	0.04	0.19	499	0.05	0.21	
<i>Organisation size:</i>							
5-24 employees	983	0.24	0.43	493	0.48	0.50	
25-49	983	0.09	0.28	493	0.17	0.38	
50-99	983	0.08	0.28	493	0.16	0.37	
100-249	983	0.09	0.29	493	0.18	0.39	
250+	983	0.50	0.50				

continued...

Appendix A continued

	All firms			SMEs			Continuous?
	N	mean	SD	N	mean	SD	
<i>Industry sector (SIC2003):</i>							
D-F: Manufacturing, Construction, Utilities	1,007	0.19	0.40	499	0.20	0.40	
G: Wholesale and retail	1,007	0.16	0.37	499	0.15	0.36	
H: Hotels and restaurants	1,007	0.10	0.30	499	0.10	0.30	
I-K: Transport and communications, Finance, Business services	1,007	0.27	0.44	499	0.26	0.44	
M: Education	1,007	0.06	0.25	499	0.05	0.23	
N: Health	1,007	0.10	0.30	499	0.10	0.30	
O: Other services	1,007	0.11	0.31	499	0.14	0.35	
<i>Region</i>							
North East	1,007	0.04	0.19	499	0.03	0.18	
North West	1,007	0.13	0.33	499	0.13	0.33	
Yorks & Humberside	1,007	0.09	0.29	499	0.08	0.27	
East Midlands	1,007	0.06	0.24	499	0.06	0.23	
West Midlands	1,007	0.07	0.26	499	0.06	0.25	
East of England	1,007	0.09	0.28	499	0.09	0.29	
London	1,007	0.15	0.36	499	0.14	0.35	
South East	1,007	0.16	0.36	499	0.17	0.38	
South West	1,007	0.09	0.29	499	0.10	0.30	
Scotland	1,007	0.10	0.30	499	0.09	0.29	
Wales	1,007	0.03	0.18	499	0.04	0.19	
<i>Year firm started:</i>							
2006-2010	1,007	0.08	0.27	499	0.14	0.35	
2001-2005	1,007	0.15	0.36	499	0.25	0.43	
1996-2000	1,007	0.12	0.32	499	0.19	0.39	
Pre 1996	1,007	0.65	0.48	499	0.42	0.49	
<i>Largest occupational group:</i>							
Professionals	1,007	0.14	0.35	499	0.12	0.33	
Associate professionals	1,007	0.11	0.32	499	0.12	0.32	
Administrative	1,007	0.10	0.30	499	0.10	0.31	
Skilled Trades	1,007	0.10	0.30	499	0.15	0.36	
Caring and leisure	1,007	0.10	0.31	499	0.11	0.31	
Sales and customer service	1,007	0.18	0.38	499	0.17	0.37	
Process, plant and machine operators	1,007	0.10	0.30	499	0.08	0.27	
Elementary occupations	1,007	0.16	0.37	499	0.15	0.36	
Owner-manager	1,007	0.60	0.74	499	0.76	0.68	
Foreign-owned	1,007	0.14	0.35	499	0.06	0.24	
Main market is international	1,007	0.17	0.38	499	0.16	0.36	
<i>Degree of market competition:</i>							
High/Very high	1,007	0.72	0.45	499	0.72	0.45	
Neither high nor low	1,007	0.13	0.34	499	0.16	0.37	
Low/Very low	1,007	0.15	0.36	499	0.13	0.33	
Count of employer networks (0-5)	1,007	0.83	0.95	499	0.78	0.87	Y

7. APPENDIX B: FULL MODELS FOR SMES, 2011-14

	p(exit) Probit	Ln(employment growth) OLS	Ln(turnover growth) OLS	p(High- growth) Probit	Ln(productivity growth) OLS
<i>Financial performance:</i>					
A lot better than average	Ref. [.]				
Better than average	0.519 [0.95]				
About average	0.89 [1.64]				
Below average/A lot below average	1.505** [2.36]				
No comparison possible	1.439** [2.16]				
Ln(Employment growth) 2008-2011		0.134** [2.51]			
Ln(Turnover growth) 2008-2011			-0.063 [-1.15]	-0.179 [-1.19]	
Ln(Labour productivity growth) 2008-2011					-0.044 [-0.79]
Ln(Labour productivity) 2011					-0.250*** [-5.23]
<i>Organisation size:</i>					
5-24 employees	Ref. [.]	Ref. [.]	Ref. [.]	Ref. [.]	Ref. [.]
25-49	-0.186 [-0.74]	-0.108 [-1.04]	-0.088 [-0.80]	-0.149 [-0.45]	0.027 [0.28]
50-99	-0.625 [-1.52]	0 [-0.00]	0.063 [0.57]	-0.102 [-0.24]	0.032 [0.31]
100-249	-0.901** [-2.21]	0.309*** [3.20]	0.215* [1.76]	0.521 [1.48]	-0.075 [-0.79]
<i>Industry sector (SIC2003):</i>					
D-F: Manuf., Construction, Utilities	Ref. [.]	Ref. [.]	Ref. [.]	Ref. [.]	Ref. [.]
G: Wholesale and retail	-0.186 [-0.43]	-0.061 [-0.52]	-0.294* [-1.78]	-0.32 [-0.82]	-0.066 [-0.57]
H: Hotels and restaurants	0.031 [0.06]	-0.1 [-0.66]	-0.369** [-2.21]	-0.621 [-1.14]	-0.410** [-2.19]
I-K: Transport and communications, Finance, Business services	0.056 [0.14]	0.007 [0.06]	-0.143 [-1.01]	-0.338 [-1.04]	-0.289** [-2.26]
M: Education	-0.593 [-0.81]	-0.02 [-0.11]	-0.606** [-2.53]	0.397 [0.70]	-0.735*** [-3.01]

continued...

Appendix B continued

	p(exit) Probit	Ln(employment growth) OLS	Ln(turnover growth) OLS	p(High- growth) Probit	Ln(productivity growth) OLS
N: Health	-0.106 [-0.21]	-0.084 [-0.43]	-0.211 [-1.06]	0.073 [0.14]	-0.278* [-1.69]
O: Other services	-0.44 [-0.98]	-0.01 [-0.08]	-0.088 [-0.55]	0.44 [1.11]	-0.287* [-1.85]
<i>Region</i>					
North East	0.548 [1.02]	0.148 [0.99]	0.037 [0.22]	0.809 [1.53]	-0.004 [-0.03]
North West	0.009 [0.02]	0.095 [0.85]	-0.018 [-0.15]	0.990** [2.45]	0.034 [0.31]
Yorks & Humberside	-1.574*** [-2.90]	0.153 [1.19]	0.058 [0.35]	1.284*** [2.88]	-0.086 [-0.62]
East Midlands	-0.533 [-1.06]	0.116 [0.67]	0.123 [0.60]	1.375*** [3.08]	0.111 [0.97]
West Midlands	0.207 [0.39]	0.033 [0.21]	0.041 [0.29]	0.308 [0.59]	0.251** [2.14]
East of England	0.478 [1.36]	-0.058 [-0.35]	-0.089 [-0.53]	0.653 [1.56]	0.12 [0.78]
London	Ref. [.]	Ref. [.]	Ref. [.]	Ref. [.]	Ref. [.]
South East	0.071 [0.20]	0.118 [1.11]	0.056 [0.60]	0.442 [1.02]	-0.005 [-0.05]
South West	0.017 [0.04]	0.017 [0.14]	0.123 [1.11]	0.174 [0.32]	0.184* [1.73]
Scotland	-0.365 [-0.80]	0.152 [1.23]	-0.019 [-0.17]	0.508 [1.06]	-0.036 [-0.29]
Wales	0.384 [0.63]	-0.027 [-0.14]	0.024 [0.11]	0.772 [1.13]	0.111 [1.02]
<i>Year firm started:</i>					
2006-2010	0.679** [2.38]	-0.126 [-0.97]	0.095 [0.59]	1.057*** [2.72]	0.124 [0.86]
2001-2005	0.296 [1.05]	-0.166* [-1.85]	0.084 [0.81]	0.785*** [3.10]	0.221*** [2.95]
1996-2000	-0.19 [-0.63]	-0.077 [-0.93]	-0.059 [-0.55]	-0.219 [-0.73]	0.056 [0.80]
Pre 1996	Ref. [.]	Ref. [.]	Ref. [.]	Ref. [.]	Ref. [.]
<i>Largest occupational group:</i>					
Professionals	-1.118** [-2.43]	-0.036 [-0.22]	-0.184 [-1.19]	-1.213** [-2.40]	0.064 [0.37]
Associate professionals	-0.403 [-0.89]	0.103 [0.71]	0.079 [0.43]	0.015 [0.03]	0.123 [0.72]

continued...

Appendix B continued

	p(exit) Probit	Ln(employment growth) OLS	Ln(turnover growth) OLS	p(High- growth) Probit	Ln(productivity growth) OLS
Administrative	-0.953* [-1.90]	0.008 [0.04]	-0.101 [-0.51]	-0.343 [-0.70]	0.119 [0.68]
Skilled Trades	-0.44 [-1.01]	0.125 [1.12]	-0.146 [-0.95]	-0.65 [-1.51]	-0.249 [-1.62]
Caring and leisure	-0.025 [-0.06]	0.147 [0.93]	-0.074 [-0.41]	-1.007* [-1.82]	-0.087 [-0.52]
Sales and customer service	-0.483 [-1.23]	0.338** [2.54]	0.212 [1.28]	-0.097 [-0.23]	-0.146 [-0.96]
Process, plant & machine operators	-1.172* [-1.89]	0.163 [1.16]	-0.067 [-0.34]	-0.675 [-1.38]	-0.151 [-0.86]
Elementary occupations	Ref. [.]	Ref. [.]	Ref. [.]	Ref. [.]	Ref. [.]
Owner-manager	0.371** [2.19]	-0.155** [-2.30]	-0.125* [-1.85]	0.035 [0.21]	0.011 [0.19]
Foreign-owned	-0.662 [-1.38]	0.036 [0.21]	-0.081 [-0.33]	0.946** [2.21]	0.165 [0.89]
Main market is international	-0.032 [-0.12]	0.1 [1.08]	0.144 [1.21]	0.399 [1.27]	0.105 [1.20]
<i>Degree of market competition:</i>					
High/Very high	Ref. [.]	Ref. [.]	Ref. [.]	Ref. [.]	Ref. [.]
Neither high nor low	0.108 [0.45]	0.092 [1.17]	-0.001 [-0.01]	-0.007 [-0.03]	-0.042 [-0.67]
Low/Very low	-0.18 [-0.44]	-0.105 [-0.93]	-0.073 [-0.58]	0.261 [0.76]	-0.038 [-0.38]
Count of employer networks	0.015 [0.13]	0.000 [-0.01]	-0.001 [-0.02]	0.113 [1.05]	0.007 [0.17]
Employment share (see Table 1)	-0.332* [-1.66]	0.467*** [4.63]	0.218** [2.15]	1.053*** [5.48]	-0.154** [-2.06]
Index of management practices	-0.146 [-1.25]	-0.014 [-0.39]	0.017 [0.40]	0.206* [1.76]	0.054* [1.72]
IMR		-0.153* [-1.89]	-0.111 [-1.22]	-0.011 [-0.06]	0.094 [1.61]
Constant	-1.524** [-2.03]	-0.512*** [-3.10]	0.057 [0.27]	-2.853*** [-5.00]	1.324*** [4.78]
N	497	428	428	428	428
adj. R-sq (OLS) / Pseudo R-sq (probit)	0.261	0.19	0.06	0.347	0.213

Notes:

1. Probit coefficients are expressed raw, not as marginal effects
2. IMR=Inverse Mills Ratio
3. t statistics in brackets
4. p<0.10, ** p<0.05, *** p<0.01

Source: WERS-BSD linked sample

8. APPENDIX C: MANAGEMENT INDEX AND FIRM PERFORMANCE (2011-14): ALL

FIRMS

	p(exit) Probit	Ln(employment growth) OLS	Ln(turnover growth) OLS	p(High- growth) Probit	Ln(productivity growth) OLS
Parsimonious specification:					
Index of management practices	-0.037** [-2.50]	-0.024 [-0.79]	0.039 [1.19]	0.037** [2.36]	0.091*** [4.01]
<i>Num. obs.</i>	1004	888	888	888	888
<i>Goodness of fit</i>	0.17	0.03	0.02	0.18	0.14
Full specification:					
Index of management practices	-0.019 [-1.30]	-0.026 [-0.85]	0.008 [0.24]	0.031** [2.03]	0.064*** [2.55]
<i>Num. obs.</i>	1004	888	888	888	888
<i>Goodness of fit</i>	0.30	0.15	0.06	0.29	0.20
Full specification with sub-indices:					
Index of HR practices	-0.012 [-0.82]	0.071** [2.21]	0.102*** [2.62]	0.060*** [3.71]	0.059* [1.90]
Index of work organisation	0.014 [1.17]	-0.104*** [-2.84]	-0.087** [-2.03]	-0.017 [-1.20]	0.031 [1.16]
Index of target setting	-0.012 [-0.80]	-0.055* [-1.71]	-0.015 [-0.41]	0.020 [1.16]	0.049* [1.99]
Above average on all three indices	-0.044 [-1.00]	0.152 [1.39]	0.044 [0.35]	-0.037 [-0.91]	-0.117 [-1.47]
<i>Num. obs.</i>	1004	888	888	888	888
<i>Goodness of fit</i>	0.30	0.18	0.09	0.31	0.20

Notes:

1. Probit coefficients expressed as marginal effects
2. t statistics in brackets; p<0.10, ** p<0.05, *** p<0.01
3. Control variables for parsimonious specification: industry sector; region; year firm started; prior growth in employment (column 2); prior growth in turnover (columns 3 and 4); prior growth in productivity and level of productivity (column 5)
4. Control variables for full specification: see Appendix B for full list
5. Goodness of fit: probits = pseudo r-squared; OLS = adjusted r-squared.

Source: WERS-BSD linked sample

ENDNOTES

ⁱ The World Management Survey only samples firms with between 50 and 10,000 employees. In their original paper, Bloom and Van Reenen (2006) report that responding firms had a mean size of 1,984 employees.

ⁱⁱ Sheehan (2014: 556) presents the results of a test for such bias. She concludes that “it is not likely to be substantial”, but cannot rule it out.

ⁱⁱⁱ Any analysis using this panel sample would thus have to rely on the respondent’s subjective ratings of the performance of the establishment, collected within the WERS survey itself, whereas a key objective of our paper is to utilise accounts-type data, which have rarely been available hitherto. The panel sample of SMEs is also relatively small, numbering fewer than 250 workplaces.

^{iv} In 2011, all organisations with an annual turnover of £73,000 or more were liable to register for VAT, whilst all those with an employee earning at least £7,475 were liable to register for PAYE.

^v Welpton (2009) provides further information on characteristics and relative merits of the BSD. See Office for National Statistics (2010, 2012) on the design of the Annual Business Survey.

^{vi} These are unweighted figures, as we focus here on the degree of internal consistency between the workplace in our sample (the unit of observation for our measures of management practice) and the firm to which it belongs (the unit of observation for our firm performance data). We could weight the data at this point, to indicate the extent to which, within the general population, workplaces are representative of firms. If we do so, we still find that the mean and median employment shares for SME workplaces are 100%. For large firms, the mean share is 18% and the median 0.5%.

^{vii} Each of the SME firms in the WERS-BSD matched dataset has only one workplace observation in WERS.

^{viii} Strictly speaking, it encompasses firms that ceased to trade and those whose turnover shrunk to a point where they were no longer liable for VAT. The refreshment sample of workplaces for WERS 2011 was drawn in September 2010; workplaces must thus have survived for an average of one year following entry onto the BSD in order to qualify for our sample (the median interview date was September 2011), from which point we trace their survival or death.

^{ix} We acknowledge that gross value-added would be preferable to total sales, but the former is not recorded in the BSD and so is only available for the minority of firms that are surveyed as part of the ONS’ Annual Business Survey.

^x Some 10 per cent of firms in our population exit (die) between 2011 and 2014. The figure is 13% among SMEs (20% among firms with 5-49 employees and 7% among firms with 50-249 employees). In terms of the unweighted sample, this gives us a sample of 55 exits among our sample of 525 SMEs. The exit rate is much lower among large firms, with only 3% of this population exiting over the period, giving fewer than 10 exits.

^{xi} We restrict the influence of extreme values in the distributions of employment growth, turnover growth and productivity growth by winsorizing at the 1st and 99th percentiles.

^{xii} This is effectively a Heckman two-step correction in those cases where the second-stage performance regression is estimated via OLS. The variable indicating the financial performance of the firm in 2011 is assumed only to affect growth in employment, turnover or productivity via its effect on the probability of firm survival. The variable is not statistically significant if entered into the second-stage performance regressions for survivors.

^{xiii} Neither Bloom et al (2017) nor Broszeit et al (2016) replicate our specification, in which the growth rate of productivity is regressed on the starting level of management practices. However, in cross-sectional regressions, Bloom et al (2017) and Broszeit et al (2016) find that a one standard deviation increase in the number of management practices is associated with levels of labour productivity that are, respectively, 21% and 11% higher.

^{xiv} Again, results for the full sample of firms are presented for comparison in Appendix C.

^{xv} If we replace the HR index with dummy variables identifying the four component practices, we find that all four are positively associated with high-growth, but only the use of recruitment tests and performance appraisals reach statistical significance at the 10 per cent level in their own right.

^{xvi} This association between target setting and productivity is driven by the use of targets for profitability and targets for productivity. Replacing the target-setting index with six dummy variables identifying each of the six types of target, we find that the coefficients on profit targets and productivity targets are both positively and statistically significant at the five per cent level. The remaining four targets are not statistically significant.