# The Role of Management Practices in Productivity: Does Family Ownership Matter?

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# Abstract

This study investigates the impact of management practices on productivity, with a focus on the moderating role of family ownership. Our findings reveal that family ownership weakens the positive relationship between management practices and productivity, particularly in SMEs and the services sector. This adverse moderating effect primarily occurs in family-managed firms; however, introducing professional management in large firms and the services sector can mitigate the negative impact. Meanwhile, our baseline results indicate that a 10% improvement in management practice scores is associated with a 5.2% increase in labour productivity. We find no statistical evidence suggesting that the impact of management practices varies across firm sizes, underscoring their universal applicability. However, this effect is significantly lower in the manufacturing sector compared to the services sector.

**Contents**

# 1    Introduction

The productivity slowdown has been a persistent challenge for most developed countries since the start of the 21st century (Bauer et al. 2020). In the UK, understanding this phenomena, alongside the widening productivity gap with other developed economies, has become a critical issue for policymakers and economists, often referred to the "productivity puzzle" (van Ark and Venables 2020). In particular, the UK has experienced a slowdown in both labour productivity and total factor productivity (TFP), with these indicators yet to return to their to their pre-2008 financial crisis peaks (Douch et al. 2023). Moreover, the UK experienced slower productivity growth compared to other countries following the 2008, recording the second-lowest labour productivity growth among the G-7 countries between 2009 and 2019 (Office for National Statistics 2020). Investigating the production function and input factors to enhance firm-level productivity is suggested as a crucial strategy for addressing the UK productivity puzzle (Dimson et al. 2016; Goodridge et al. 2018). The focus of this paper is on boosting firm-level productivity by improving efficiency in the use of input factors.

A recent and pioneering research field has focused on the role of management practices in explaining productivity (Bloom and Van Reenen 2007). Management practices are usually considered as a series of structured managerial methods, such as continuous improvement, employment training and process management, that can improve working methods and productive efficiency (Grandzol and Gershon 1997). Bloom and Van Reenen (2007) provide the evidence for a positive relationship between management practices and performance measures including productivity. Broszeit et al. (2019) explore the heterogeneity among small, medium, and large German firms, finding that the effect of management practices on productivity is stronger in larger firms. Furthermore, Bloom et al. (2022) indicate that management practices have a stronger effect on productivity in manufacturing firms compared to services sector based on Mexican data.

While the existing literature continues to develop the understanding of the relationship between management practices and productivity, less attention has been given to the mechanisms of the impact of management practices on productivity. Bloom and Van Reenen (2007) suggest considering the role of family ownership in this context. This raises the question of how family ownership interacts with the management practices-productivity relationship, given potential differences in management styles and economic objectives present in family firms (Holt et al. 2017) This paper investigates how management practices influence productivity within the context of family ownership, focusing specifically on the moderating effect of family ownership.

Our contribution to the literature is twofold. First, we highlight the moderating role of family ownership and family management control, enriching the existing literature on the relationship between management practices and productivity (Bloom and Van Reenen 2007; Bloom et al. 2019; Broszeit et al. 2019). By investigating family ownership, we provide insights into the consequences of lower-quality management practices in family firms. Our findings indicate that family ownership generally weakens the positive impact of management practices on productivity, particularly in managerial areas such as target setting, performance review, and bonus systems. Heterogeneity analysis reveals that this negative moderating effect is especially pronounced in SMEs and in the services sector. However, this adverse effect can be mitigated when family ownership is separated from family control, as the moderating effect of professional management is statistically insignificant in large firms and the services sector.

Secondly, we explore the UK's stagnant productivity growth (Jacob and Mion 2023) through the lens of firm management. To our knowledge, this is the first study to link the UK Management and Expectations Survey (MES) with the Annual Respondents Database X (ARDx), a high-quality dataset on firm performance and resources. Unlike other management surveys, MES offers broader coverage of SMEs, large firms, manufacturing, and services, enhancing representativeness and enabling heterogeneity analysis. Our findings reveal a significant positive relationship between management practices and productivity overall. However, we find no significant difference in this effect between SMEs and large firms, extending Broszeit et al. (2019) who do not conduct formal tests. Moreover, management practices have a significantly lower impact on productivity in manufacturing than in services, contrasting with Bloom et al. (2022), who find stronger effects in manufacturing using Mexico data. This suggests that the inefficiency of management practices, particularly in manufacturing, may hinder productivity growth in the UK.

The paper is structured as follows: Section 2 reviews the literature on the relationship between management practices and productivity, as well as the moderating role of family firms. Section 3 outlines the data sources, key variables and the model. Section 4 presents the empirical results, and Section 5 concludes.

## 2 Literature review

### 2.1 The Role of Management Practices in Productivity

Early research in the impact of management practices on productivity mainly focuses on human resource management (HRM) practices, establishing a foundation for understanding how these practices influence firm performance. Guest et al. (2003) demonstrate a strong link between HRM practices, productivity, and financial performance, suggesting that effective HR practices can boost worker motivation and

lead to improved organisational outcomes. Similarly, Datta et al. (2005) highlight the importance of management practices and organisational behaviours, particularly those developed by educational institutions specializing in management, in driving firm performance. However, the external validity of many of these theoretical analyses and case studies is limited, restricting our understanding of how management practices impact productivity in broader contexts.

Quantitative empirical research on the relationship between management practices and firm productivity originates from Bloom and Van Reenen (2007). The authors collect survey data in the form of the World Management Survey (WMS) to establish a positive correlation between structured management practices and firm productivity. This is the first study providing large-scale evidence on the importance of structured management practices such as performance monitoring, target setting, and incentive systems, in enhancing productivity. Bloom et al. (2013a) expand on this by utilizing data from the Management and Organizational Practices Survey (MOPS) in the United States, confirming that firms adopting more structured management practices tend to achieve greater productivity and profitability. Their subsequent analyses (Bloom et al. 2019) further demonstrate significant heterogeneity in the management practices – productivity relationship across different sectors, with factors such as the business environment and learning spillovers amplifying the effects of management practices.

The adoption of specific management practices, such as monitoring, key performance indicators (KPIs), and employment practices, is shown as playing a crucial role in enhancing productivity. Monitoring by higher-level leaders incentivizes employees to work more efficiently, boosting productivity through increased motivation (Böckerman and Ilmakunnas 2012). The use of KPIs aligns employee efforts with organisational goals, showing a clear framework for performance improvement (Hartono and Sheng 2016). Moreover, flexible target setting, as discussed by Arnold and Artz (2015), allows firms to adapt to changing business conditions, further supporting productivity in dynamic environments. Employment practices, including training and promotion systems, also contribute significantly to productivity by improving workforce capabilities and fostering positive manager-employee relationships (Sekhar et al. 2018). In summary, structured management practices are essential for driving productivity improvements, and empirical evidence suggests that firms adopting these practices experience significant gains in performance.

## 2.2 The Moderating Role of Family Ownership

While structured management practices are widely shown to increase productivity, the presence of family ownership introduces challenges that may condition this relationship. The special characteristics of family ownership could have various effects on the relationship between management practices and productivity,

particularly for specific practices. Family-owned firms, which often prioritise family control and informal management over structured, formalized management practices, may experience a weakening of the positive effects that these practices typically have on productivity.

Blau and DeVaro (2007) indicate that promotion decisions in family-owned firms, even when structured promotion paths exist, are often influenced by unmeasured factors such as discrimination or nepotism, reducing employee motivation and satisfaction, ultimately affecting productivity. This challenge is exacerbated by the informal management styles prevalent in family firms, particularly SMEs, which rely on informal practices that undermine the benefits of structured management systems (Kotey and Folker 2007). Potential unfair promotion practices, including less stringent evaluation criteria for family members, create ambiguity and reduce motivation among non-family employees, hindering productivity growth (Giovannini 2010; Stewart and Hitt 2012; Gelens et al. 2013).

Family firms often prioritize non-economic goals, such as maintaining family control and social-emotional wealth, over economic performance, which can increase business risks and lead to nepotistic promotions that disregard merit (Zellweger et al. 2012; Matzler et al. 2015). This preference for family members can cause a loss of talent and diminish the effectiveness of employment practices on productivity. Target setting in family firms also tends to emphasize preserving legacy and values, relying on trust-based relationships over measurable outcomes, which can further reduce the effectiveness of management practices in enhancing productivity (Cunningham and McGuire 2019; Haslan et al. 2019).

Despite these challenges, professionalization in family firms can improve productivity. Delegating responsibilities to non-family professional managers promotes merit-based decision-making, reducing nepotism and fostering fair evaluations and incentive systems (Hall and Nordqvist 2008). Professional managers bring specialized expertise, stronger governance, and impartial practices, enhancing firm performance (Chang and Shim 2015; Diéguez-Soto et al. 2016; Purkayastha et al. 2019). However, nepotistic leadership can undermine these benefits, as observed by Huang et al. (2015), making professional management a critical factor for improving productivity in family firms.

In conclusion, despite setting in place structured management practices as in non-family firms, family ownership is likely to negatively moderate the positive effect of management practices on productivity. The tendency toward informal management, the prioritization of non-economic goals, and the presence of nepotism all contribute to a reduction in the effectiveness of management practices that typically enhance productivity. These factors make it difficult for family firms to fully achieve the benefits of structured management systems. However, under certain conditions, such

as when non-family professionals are allowed to implement formalized practices, family firms can still leverage these management strategies to improve performance, suggesting that the negative moderating role of family ownership can be partially mitigated.

## 3    Methodology

### 3.1    Data source and the sample

The first large-scale survey related to management practices is the World Management Survey (WMS). It has major five waves, conducted in 2004, 2006, 2009/10, 2013 and 2014 (Bloom et al. 2016). Initially, the survey covered four countries: the US, UK, France, and Germany (Bloom and Van Reenen 2007). This international survey samples manufacturing firms with the employment range between 50 to 1000. Adopting a very similar survey design as the WMS, the US Census Bureau conducted the Management and Organizational Practices Survey (MOPS). Bloom et al. (2013a) and Bloom et al. (2019) describe MOPS as surveying approximately 35,000 manufacturing plants in two waves in 2010 and 2015. This survey addressed a drawback of the WMS by targeting top-level management, rather than solely middle managers. According to Broszeit et al. (2019) and Jirjahn et al. (2024), Germany conducted the German Management and Organizational Practices Survey (GMOP) in late 2014 to early 2015 to collect the retrospective information of 2008 and 2013. The frame of the GMOP closely followed that of the MOPS, collecting data from over 1,900 establishments across German manufacturing sector. The data address a sampling limitation of the WMS, by allowing the inclusion of smaller establishments. This survey covered respondents with 25 or more employees.

Following the examples from the USA and Germany, in the UK, the Office for National Statistics (ONS) has conducted two waves of the Management and Expectation Survey (MES) (Office for National Statistics 2023). The first wave of the MES was conducted in 2016. The second wave was conducted in 2020. The MES 2020 includes recall questions regarding 2019 as well as inquiries about 2020. Questionnaire items are listed in Table A1 of the appendix. We combine the two waves to construct a dataset comprising 32,447 observations, with MES 2016 containing 7,687 valid observations and MES 2020 including 12,380 valid observations. Among them, 2,238 firms provide information for all three years, as shown in Table A2 of the appendix.

Compared to other surveys in developed countries, the MES has two main advantages. First, it includes small firms with ten or more employees, offering insights into the management practices of small businesses. Second, it covers a wide range of industries, spanning from manufacturing to services sector. We use the MES

data as our primary dataset, which provides information on management practices scores and firm-level characteristics.

The Annual Respondents Database X (ARDx), maintained by the ONS, is an aggregated business survey database, drawing samples from major administrative business surveys such as the Annual Business Survey, the Annual Business Inquiry, and the Business Register and Employment Survey (Office for National Statistics 2024). The ARDx dataset covers the period from 2008 to 2020 and provides relevant variables for estimating production functions, including gross value added (GVA), the number of employees, estimated capital stock. However, since the MES sample, being a voluntary survey, is primarily drawn from the Annual Business Survey, previous MES respondents, and the Inter-Departmental Business Register (IDBR), its sample composition differs partially from that of ARDx. As a result, the two datasets do not entirely overlap.

We link the ARDx data with the MES data using a unique firm identifier, finally resulting in a merged dataset with 12,567 observations. The merged dataset encompasses 75 industries classified under 2-digit Standard Industrial Classification (SIC) codes, including 23 manufacturing sectors and 46 service sectors[1]. It also includes 11 first level International Territorial Level (ITL1) regions/nations across Great Britain (excluding Northern Ireland) and covers three years: 2016, 2019, and 2020. The merged dataset comprises 4,526 observations in 2016, 4,664 observations in 2019, and 3,377 observations in 2020. Among these observations, 385 firms are recorded across all three years as shown in Table A2.

Table A3 in the appendix presents sample coverages of the MES data and the merged data across family-owned and non-family-owned firms. Table A4 in the appendix reports of sample distribution by regions and industries. After merging the MES data with the ARDx data, the composition of each sample group remains largely consistent. The major change is that SMEs[2] account for a higher proportion in the merged sample, comprising 77% of the overall merged sample compared to 33% in the MES data. In the MES data, family-owned firms account for 63% of the sample, while non-family-owned firms make up 37%. In the merged data, there is a similar distribution, with family-owned firms representing 60% and non-family-owned firms 40%. Observations in manufacturing and services sector account for 21% and 71% of the merged sample, respectively, in the MES data, and 28% and 63%, respectively, in the merged data.

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[1] The manufacturing sectors are defined by 2-digit SIC codes 10 to 33. The service sectors are defined by 2-digit SIC codes 35 to 96, excluding codes 41 to 43, which pertain to the construction section.

[2] SMEs are defined as firms with fewer than 250 employees, while large firms have more than 250 employees

## 3.2 Variables

The key independent variable is the management practice score, which represents the average score across four categories of management practices: continuous improvement, key performance indicators (KPI), targets, and employment practices. The management practice score aims to capture the degree to which firms adopt structured practices, although it is recognised that management practice is a multidimensional concept (Bloom et al. 2019). The continuous improvement section measures responses to problems. The KPI section measures the tracking and review of employees' performance. The targets section measures timeframe achievement, difficulty levels, awareness, and incentives related to targets. The employment practices section measures employees' promotion, training, and the timeframe for addressing under-performance. Table A5 in the appendix presents the summary statistics of management practice scores for the MES data, the merged data and un-merged part of MES data.

The main dependent variable is labour productivity, calculated as GVA per worker. GVA at basic prices is approximated as output at basic prices minus intermediate consumption at purchaser's prices (Office for National Statistics 2024).

The variables for estimating the production function are the number of employees, capital stock per worker and intermediate input per worker. Capital stock is estimated by ONS using a perpetual inventory method and is provided in ARDx database. GVA and capital stock are deflated using 2-digit SIC industry GDP deflators[3].

Other variables for firm characteristics are defined as follows. Family ownership (Broszeit et al. 2019) based on the MES questionnaire item: "Which of the following applies to your business's ownership structure?" If the response is marked as family-owned, the family ownership variable is coded as 1, and 0 otherwise. The question "Did the managing director or equivalent have any form of family connection or relationship with the business owners?" identifies a family management variable, and therefore combining these two identifies ownership and control in family firms. Based on our merged data, no firm switches its family ownership or family management during the research period. Export status (Jirjahn et al. 2024) is coded as 1 if the firm reports exporting activities, and 0 otherwise. Foreign ownership is defined as ultimate ownership held by non-UK owners. Company status (Audretsch and Belitski 2020) is coded as 1 if the firm's legal status is a limited company, and 0 otherwise. Finally firm age is also included (Bloom et al. 2019).

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[3] Data of 2-digit industrial GDP deflators is available at ONS website:
https://www.ons.gov.uk/economy/inflationandpriceindices/datasets/experimentalindustrydeflatorsuknonseasonallyadjusted

Table 1 provides the summary statistics for main variables in the merged dataset. Table A6 in the appendix shows the correlation matrix.

## 3.3 Model specification

To investigate the relationship between management practices and productivity, we apply our merged cross-section data and follow Bloom et al. (2019) and Bloom et al. (2013a) approach to derive an extensive production function as below:

$$Y_i = A_i K_i^{\alpha_k} L_i^{\alpha_l} e^{\beta M_i} e^{\mu X_i} \qquad (1)$$

where $Y_i$ is GVA of a firm $i$, $A_i$ is total factor productivity (excluding management practices), $K_i$ is capital stock, $L_i$ is labour input, $X_i$ is a vector of firms' characteristics, and $M_i$ is management practice score.

Dividing by labour input and expressing in natural logarithms, we can rewrite equation (1) as:

$$Ln\left(\frac{Y_i}{L_i}\right) = \alpha_k \ln\left(\frac{K_i}{L_i}\right) + (\alpha_k + \alpha_l - 1)\ln(L_i) + \beta M_i + \mu X_i + f_d + \tau_t + \gamma_r + \zeta_i$$
$$(2)$$

where the TFP term $A_i$ is subsumed with a set of error term $\zeta_i$, industry fixed effects $f_d$, time fixed effects $\tau_t$, and region fixed effects $\gamma_r$. Other variables are the same as in equation (1). $\beta$ is the key coefficient of interest, capturing the impact of management practices on productivity. This equation is estimated using the Ordinary Least Squares (OLS) method with clustered robust standard errors at the establishment level.

## 4 Empirical results

## 4.1 Baseline results

Table 2 reports the results of specification (2). Column (1) indicates that there is a positive correlation between management practice score and labour productivity based on the overall sample. The estimated coefficient on management practices is positive and significant, showing that a 10% increase in management practice score is associated with a 5.2% increase in labour productivity ($= 100(exp(0.0504) - 1)$) with controlling for firm characteristics as well as industry, year, and region fixed effects.

The relationship between management practices and productivity may vary across firm sizes and industries (Broszeit et al. 2019; Bloom et al. 2022). Building on their work, we examine the heterogeneity across firm sizes (SMEs and large firms) and

industries (manufacturing and services). As shown in columns (2) to (5), the impact of management practices on productivity is significantly positive across SMEs, large firms, manufacturing sector, and service sector. Specifically, a 10% improvement in management practices corresponds to increases in labour productivity of 5.11%, 5.56%, 3.05%, and 5.74%, respectively. Our baseline finding in manufacturing sector shows that the impact of management practices in the UK is lower compared to findings from manufacturing-based survey samples in the USA (Bloom et al. 2013a; Bloom et al. 2019) and Germany (Broszeit et al. 2019). Our findings indicate that the coefficient of management practices on productivity is lower in SMEs compared to large firms. However, contrary to the existing literature, we find that the impact of management practices is lower in manufacturing sector than in service sector. Given identical average levels of management practice adoption in manufacturing and services sectors, this finding could be explained by a range of additional organisational factors which might explain productivity in manufacturing and/or the higher level of management practice effectiveness in the service sector. This merits further detailed attention beyond the focus of this paper.

To examine the statistical differences in coefficients across groups, we apply Fisher's permutation test (Yu 2024), which compares key regression coefficients and determines whether the observed differences stem from genuine underlying disparities between groups or merely result from random variation. The results indicate that there is no statistical evidence to suggest that the impact of management practices on productivity differs significantly between SMEs and large firms, although we observe higher coefficients for management practices in large firms compared to SMEs. The coefficient for management practices in manufacturing sector is lower than that in the service sector.

Our findings suggest that improved management practices are associated with similar increases in productivity for both SMEs and large firms, indicating that management practices may have universal applicability across firms of varying sizes. However, the statistically significant lower impact of management practices in the manufacturing sector contrasts with the findings of Bloom et al. (2022), who observe a greater effect of management practices in manufacturing based on data from Mexico. Their Mexican data consists of 27% manufacturing sector and 73% services sector, which is comparable to the composition of our dataset.

Table A5 in the appendix shows that the mean management practice score in the manufacturing sector (0.642) is similar to that in the services sector (0.645), indicating comparable overall levels of management practices. However, the lower marginal effect of management practices in the manufacturing sector suggests limited room for further improvement. This could be due to the widespread adoption of standardized and systematic management processes in manufacturing, where the transformation of management practices into productivity gains may have already

approached saturation in our UK sample. Additionally, despite similar management practice scores, the smaller impact on productivity in the manufacturing sector may reflect lower efficiency in utilizing these practices. Compared to the services sector, the manufacturing sector in the UK may be less effective in integrating technology with management practices, which limits the potential for translating management improvements into productivity growth.

Beyond examining the effect of the overall management practice score, Table A7 in the appendix analyses the effects of its four components: Continuous improvement, KPIs, Targets, and Employment practices, which collectively form the average as the overall score. Each component shows a positive and statistically significant association with labour productivity at the 1% level. Among them, Employment Practices exhibit the largest effect, followed by Continuous Improvement, KPIs, and Targets.

Further, we test the robustness of our results using alternative specifications of productivity, the results are reported in Table A8 of the appendix. In column (1), following Bloom and Van Reenen (2007), we use an alternative production function, where real turnover per worker is the dependent variable and intermediate inputs are among the controls. The result suggests that the effect of management practices on productivity is positive and significant at 1%. In column (2), we regress the management practice score on TFP, following the model of Bender et al. (2018), who move labour and capital to the left-hand side of the production function to examine the impact of management practices on TFP. This adjustment isolates the direct effects of labour and capital on output, enabling TFP to more accurately capture the influence of management practices while mitigating omitted variable bias. Our TFP is estimated using the ARDx data from 2016 to 2020 across 2-digit SIC industries. The finding reveals a significantly positive relationship between management practices and TFP. In column (3), we apply alternative method of Levinsohn and Petrin (2003) to estimate the production function with management practice score, as used by Bloom et al. (2016). The results confirm a robust positive association between management practices and productivity. In column (4), we include firm-level fixed effects in specification (2). The result shows a positive relationship between management practices and productivity at the 5% significance level. This finding aligns with existing literature (Bloom et al. 2013a; Bloom et al. 2019; Broszeit et al. 2019) which similarly observes a reduced coefficient for management practices on productivity after controlling for firm-level fixed effect. Since our dataset is cross-sectional and contains only a small number of firms with complete records for all three years, we do not adopt this specification in our main analysis, as incorporating firm-level fixed effects substantially reduces the sample size.

In the next set of robustness checks, we address potential endogeneity of management practice by applying a two-stage least squares (2SLS) technique to our specification

(2). The results are presented in Table A6 of the appendix. In columns (1) and (2), according to Fisman and Svensson (2007), we use the region-industry-year averages of the management practice score as an instrumental variable. In columns (3) and (4), in line with Cornett et al. (2007), we employ the lagged management practices score as an instrument. The p-value from the LM test and the Wald F-statistic confirm that there are no issues with weak identification or under-identification. The coefficient of management practices in column (2) is significantly and positively associated with labour productivity, and this relationship remains robust in column (4), despite dropping some observations because of lagged values. Subject to the usual limitations of modelling endogeneity, these 2SLS findings are consistent with causality which runs from management practice to productivity. This causal inference, based on a large-scale dataset, complements the findings of Bloom et al. (2013b), who conduct a field experiment with Indian textile firms and find that the consultancy interventions on management practices lead to improved productivity performance.

## 4.2    The moderating effect of family ownership

To explore the potential variation in the impact of management practices on productivity, we introduce interaction terms between family ownership dummies and management practice score and in include them in specification (2). The results are presented in Table 3. Column (1) shows that family ownership significantly weakens the relationship between management practices and productivity, suggesting that the efficiency of management practices may be lower in family-owned firms compared to non-family-owned firms. Specifically, the overall marginal effect of management practice on productivity is 0.429 (0.672-0.243) with the negative moderating effect of family ownership, which is lower than 0.504 of the baseline finding in column (1) of Table 2. Further, based on different control structures, we categorise family-owned firms into those owned and run by the family and those owned but not run by the family. Column (2) indicates that both professional management and family management negatively influence the effect of management practices on productivity.

In the next step we are looking into composition of management practice score. As, it consists of four components (continuous improvement, KPIs, targets, and employment practices), we compute the interactions between each sub-score and family ownership and include them in specification (2). The results, as presented in Table 4, indicate that family ownership significantly weakens the effects of KPIs and Targets, with significance levels of 10% and 5%, respectively, as shown in columns (2) and (3). In contrast, columns (3) and (4) reveal no significant moderating effect of family ownership on the impacts of Continuous Improvement and Employment Practices.

These findings suggest that among all components, the effect of target setting on productivity is most significantly and negatively influenced by family ownership.

KPIs include the number of KPIs and the frequency of reviewing progress. Targets compass the timeframe for achieving targets, target difficulty, target awareness, and performance-based bonuses. This finding supports our previous analysis that family-owned firms tend to prioritize non-economic objectives and may implement stricter and potentially biased performance-based bonus evaluations for non-family member employees. This suggests that although family-owned firms may establish certain structured management practices, their impact on productivity could be reduced.

As Blake and Gangestad (2020) highlight, tests of interaction effects may suffer from insufficient statistical power due to limited sample size, measurement error, and improper effect size estimation. Following their recommendations, we assess the robustness of our findings in Tables A10 and A11 in the appendix. In Table A10, we employ OLS with bootstrapped standard errors, which enhances the reliability of significance testing by obtaining more robust standard errors through resampling. In Table A11, we implement Bayesian linear regression, which mitigates the issue of limited statistical power in small samples by integrating prior information with likelihood to update the posterior distribution, without relying on large-sample assumptions. Both Tables A10 and A11 consistently indicate robust negative moderation effects of family ownership on the relationship between management practices and labour productivity, as well as negative moderation effects of family management and professional management.

### 4.3 Heterogeneity in the moderating effect

Following our heterogeneity analysis on baseline findings, we examine the heterogeneity of the moderating effect of family ownership across firm sizes (SMEs and large firms) and industries (manufacturing and services).

Table A8 reports the overall moderating effect of family ownership across firm sizes and industries. The results show that the negative moderating effect is statistically significant in SMEs and the services sector. When considering the moderating effect of family ownership, the overall impact of management practices on productivity decreases to 0.425 (0.695 - 0.270) in SMEs and 0.472 (0.741 - 0.269) in the services sector, both of which are lower than the baseline estimates of 0.499 for SMEs and 0.559 for the services sector. In contrast, the moderating effect is not statistically significant in large firms or in the manufacturing sector.

In Table 5, we examine the moderating effects of two categories of family ownership (professional management and family management) across groups. Column (1) indicates that, in SMEs, family ownership, whether under professional or family management, significantly reduces the impact of management practices on productivity. Moreover, the magnitude of the moderating effect is similar for both categories of family ownership in SMEs. Column (2) shows that for large firms, the

negative and statistically significant moderating effect persist only for family management. In large family-owned firms that are not managed by family members, there is no evidence showing the adverse impact on the relationship between management practices and productivity. This suggests that while family ownership can undermine the effectiveness of management practices, large family-owned firms that employ professional managers can mitigate this negative moderating effect. Moreover, we apply Fisher's permutation test to assess the significance of the difference between the two groups of coefficients representing the moderating effect of family management. The results indicate that the negative moderating effect of family management is statistically significantly greater in SMEs compared to large firms, suggesting that larger family-owned firms are better positioned to mitigate the disadvantages associated with family management.

Columns (3) and (4) explore sectoral differences. Column (3) indicates that in the manufacturing sector, the effect of management practices in family-owned firms is not significant. However, in services sector, family management significantly negatively moderates the relationship between management practices and productivity. Moreover, when distinguishing between professional management and family management, the negative moderating effect of family management in the services sector is found to be greater than the overall moderating effect reported in Table A8. Due to the influence of family management, the overall impact of management practices on productivity in the services sector is reduced to 0.436 (0.751 - 0.316). This sectoral difference may be attributed to the nature of production processes in manufacturing versus services sector. Manufacturing firms typically have structured and standardized production processes, meaning that even family members working within the firm are more likely to adhere to structured management practices. In contrast, the more flexible production methods in services sector make the negative effects of relying on familial ties and informal management practices more obvious.

Since the negative moderating effect is primarily observed in SMEs and services sector, in Table A9 of the appendix, we further examine this effect in manufacturing SMEs in column (1), in services SMEs in column (2) and services large firms in column (3). The only statistically significant finding is the moderating effect of family management in services SMEs shown in column (2). The moderating effect of family ownership on the impact of management practices on productivity primarily affects SMEs in the services sector. However, introducing professional management could improve this issue.

## 5 Conclusion

Our primary finding reveals that management practices are significantly and positively associated with productivity, aligning with existing literature. Furthermore, we find that there is no evidence showing that this effect is different between SMEs

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and large firms. It implies that the effect of management practices on productivity is universal across firm sizes. Furthermore, the effect in manufacturing sector is statistically significantly lower than services sector.

These findings indicate that, while management practices in the UK generally contribute to productivity growth, there is inefficiency particularly in the manufacturing sector. Furthermore, relative to findings from manufacturing-based studies in the US and Germany, the effect of management practices on productivity in UK manufacturing is weaker. This may suggest that implementation of management practices in the UK's manufacturing sector is not fully optimized, limiting their potential to enhance productivity effectively. Although the UK economy has increasingly shifted towards the services sector in recent years, with manufacturing's share declining, the limited productivity potential and diminishing marginal returns in manufacturing may constrain overall productivity growth and potential global competitiveness.

Furthermore, we focus on the moderating effect of family ownership on the relationship between management practices and productivity. We find that family ownership significantly weakens the positive impact of management practices, particularly in the areas of KPI monitoring and target setting. The distinction between professional management and family management becomes clearer in the heterogeneity analysis. The moderating effect of professional management is only significantly negative for SMEs. While both family-owned SMEs and large firms exhibit a negative moderating effect of family management, the effect is significantly stronger in SMEs. Regarding industry differences, family management has no significant impact in the manufacturing sector but plays a negative moderating role in the services sector, with the most pronounced effect observed in SMEs within this sector.

Our findings further suggest that the adverse moderating effect of family ownership primarily stems from the family's direct involvement in management, rather than ownership alone. When family firms employ professional managers and effectively separate management control from ownership, the negative moderating effect becomes insignificant, as seen in large firms and in the services sector.

The presence of professional managers and the separation of ownership and control enable management to implement structured management practices in a more objective and impartial manner, reducing the influence of family ties and informal governance. This enables management practices to effectively contribute to productivity. KPI monitoring and target setting are specific areas that have been widely discussed as potentially influenced by the characteristics of family firms. When monitoring the KPIs of family member employees, family firms may not strictly adhere to established rules but instead adopt a vague and informal approach to

supervision. In terms of target setting, review, and performance bonuses, there may be disparities and unfairness between family and non-family members, which could negatively impact the effectiveness of structured management practices. Moreover, considering firm size and industry characteristics, family SMEs are more likely to be influenced by informal factors in the management process. In contrast to the structured management and supervision typically required in manufacturing processes, the flexible nature of services sector operations makes the interference of family ties and informal management with structured management practices more pronounced.

Therefore, in addressing the UK productivity puzzle, the adoption of structured management practices could be a generally significant strategy for improving productivity. However, family firms may experience a negative moderating effect on this relationship between management practices and productivity. We propose that supporting and incentivising the professionalisation of management could enhance the effectiveness of management practices in boosting productivity for family SMEs in services sector. Family firms should be encouraged to establish fair supervision and evaluation procedures within the organisation, ensuring equal treatment for both family and non-family employees. This would help mitigate the negative impacts of nepotistic, informal and ambiguous management, allowing modern structured management practices to more effectively contribute to productivity improvements.

**Table 1: Summary statistics**

| Variable | Mean |
|---|---|
| ***Overall sample (N: 12567)*** | |
| Ln (GVA per worker) | 3.778 |
| Management practice score | 0.639 |
| Ln (employment) | 4.481 |
| Ln (capital stock per worker) | 0.575 |
| Company status (D) | 0.911 |
| Family ownership (D) | 0.597 |
| Foreign ownership (D) | 0.159 |
| Export status (D) | 0.346 |
| Ln (firm age) | 3.008 |
| Firm owned and run by family (D) | 0.423 |
| Firm owned but not run by family (D) | 0.173 |
| ***Family-owned firms (N: 7503)*** | |
| Ln (GVA per worker) | 3.730 |
| Management practice score | 0.614 |
| Ln (employment) | 4.188 |
| Ln (capital stock per worker) | 0.510 |
| Company status (D) | 0.970 |
| Foreign ownership (D) | 0.063 |
| Export status (D) | 0.335 |
| Ln (firm age) | 2.971 |
| Firm owned and run by family (D) | 0.709 |
| Firm owned but not run by family (D) | 0.290 |
| ***Non-family-owned firms (N: 5064)*** | |
| Ln (GVA per worker) | 3.848 |
| Management practice score | 0.676 |
| Ln (employment) | 4.914 |
| Ln (capital stock per worker) | 0.671 |
| Company status (D) | 0.824 |
| Foreign ownership (D) | 0.300 |
| Export status (D) | 0.363 |
| Ln (firm age) | 3.063 |

Note: Dummy variables are denoted as D in parentheses.

Source: author's own calculations from ONS ARDx and MES surveys.

**Table 2: Baseline results**

| Dependent variable: Ln (GVA per worker) | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Overall | SMEs | Large | Manufacturing | Services |
| Management score | 0.504*** | 0.499*** | 0.541*** | 0.300*** | 0.559*** |
| | (0.054) | (0.058) | (0.155) | (0.094) | (0.075) |
| Ln (employment) | -0.056*** | -0.069*** | -0.024 | -0.026* | -0.065*** |
| | (0.008) | (0.012) | (0.008) | (0.008) | (0.008) |
| Ln (capital stock per worker) | 0.133*** | 0.126*** | 0.147*** | 0.129*** | 0.136*** |
| | (0.005) | (0.006) | (0.011) | (0.009) | (0.007) |
| Family-owned firm | -0.104*** | -0.106*** | -0.104*** | -0.100*** | -0.098*** |
| | (0.019) | (0.021) | (0.036) | (0.029) | (0.025) |
| Foreign-owned firm | 0.217*** | 0.214*** | 0.223*** | 0.132*** | 0.279*** |
| | (0.025) | (0.030) | (0.046) | (0.036) | (0.036) |
| Company status | 0.379*** | 0.389*** | 0.287*** | -0.059 | 0.389*** |
| | (0.040) | (0.048) | (0.067) | (0.278) | (0.041) |
| Export status | 0.121*** | 0.116*** | 0.131*** | 0.020*** | 0.197*** |
| | (0.021) | (0.023) | (0.053) | (0.031) | (0.029) |
| Ln (firm age) | 0.059*** | 0.059*** | 0.049 | 0.028 | 0.079*** |
| | (0.014) | (0.015) | (0.032) | (0.024) | (0.018) |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Region FE | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes |
| N | 12567 | 9711 | 2856 | 3536 | 7961 |
| R-sq | 0.356 | 0.316 | 0.477 | 0.183 | 0.375 |
| Fisher P-value | | -0.042 | | 0.258** | |

Notes: All models are estimated using OLS. Column (1) utilizes the overall sample, Column (2) focuses on SMEs, Column (3) examines large firms, Column (4) covers manufacturing sector, and Column (5) covers the services sector. Fisher p-value is calculated by conducting Fisher's permutation test, which tests the difference in coefficients of management practice between two sample groups. A significant p-value means there is a statistically significantly difference between two groups. Cluster robust standard errors at the establishment level are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.
Source: authors' own calculations from ONS ARDx and MES surveys.

### Table 3: Moderation effects of family ownership

| Dependent variable: Ln (GVA per worker) | (1) | (2) |
|---|---|---|
| | OLS | OLS |
| Management practice score | 0.672*** | 0.682*** |
| | (0.099) | (0.099) |
| Management practice score× family ownership | -0.243** | |
| | (0.112) | |
| Management practice score× firm owned but not run by family | | -0.280* |
| | | (0.153) |
| Management practice score× firm owned and run by family | | -0.261** |
| | | (0.116) |
| Ln (employment) | -0.058*** | -0.059*** |
| | (0.008) | (0.008) |
| Ln (capital stock per worker) | 0.133*** | 0.133*** |
| | (0.005) | (0.005) |
| Family ownership | 0.054 | |
| | (0.076) | |
| Firm owned but not run by family | | 0.116 |
| | | (0.102) |
| Firm owned and run by family | | 0.043 |
| | | (0.079) |
| Foreign ownership | 0.213*** | 0.204*** |
| | (0.025) | (0.025) |
| Company status | 0.381*** | 0.384*** |
| | (0.040) | (0.040) |
| Export status | 0.122*** | 0.120*** |
| | (0.021) | (0.021) |
| Ln (firm age) | 0.059*** | 0.061*** |
| | (0.014) | (0.014) |
| Year FE | Yes | Yes |
| Region FE | Yes | Yes |
| Industry FE | Yes | Yes |
| N | 12567 | 12567 |
| R-sq | 0.357 | 0.357 |

Notes: All models are estimated using OLS. Cluster robust standard errors are reported at the establishment level in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Source: authors' own calculations from ONS ARDx and MES surveys.

**Table 4: Moderation effects of family ownership by sub-scores**

| Dependent variable:<br>Ln (GVA per worker) | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Continuous improvement | 0.306*** | | | |
| | (0.064) | | | |
| Continuous improvement× family ownership | -0.118 | | | |
| | (0.076) | | | |
| KPIs | | 0.305*** | | |
| | | (0.068) | | |
| KPIs× family ownership | | -0.128* | | |
| | | (0.076) | | |
| Targets | | | 0.274*** | |
| | | | (0.072) | |
| Targets× family ownership | | | -0.167** | |
| | | | (0.085) | |
| Employment practices | | | | 0.325*** |
| | | | | (0.061) |
| Employment practices× family ownership | | | | -0.074 |
| | | | | (0.069) |
| Ln (employment) | -0.039*** | -0.046*** | -0.037*** | -0.057*** |
| | (0.007) | (0.008) | (0.007) | (0.008) |
| Ln (capital stock per worker) | 0.134*** | 0.134*** | 0.134*** | 0.134*** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| Family ownership | -0.009 | -0.041 | -0.001 | -0.063 |
| | (0.066) | (0.044) | (0.057) | (0.050) |
| Foreign ownership | 0.218*** | 0.217*** | 0.221*** | 0.222*** |
| | (0.025) | (0.025) | (0.025) | (0.025) |
| Company status | 0.390*** | 0.380*** | 0.392*** | 0.3798*** |
| | (0.040) | (0.040) | (0.040) | (0.040) |
| Export status | 0.127*** | 0.124*** | 0.128*** | 0.127*** |
| | (0.021) | (0.021) | (0.021) | (0.021) |
| Ln (firm age) | 0.055*** | 0.054*** | 0.053*** | 0.059*** |
| | (0.014) | (0.014) | (0.014) | (0.014) |
| Year FE | Yes | Yes | Yes | Yes |
| Region FE | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes |
| N | 12567 | 12567 | 12567 | 12567 |
| R-sq | 0.354 | 0.353 | 0.352 | 0.355 |

Notes: All models are estimated using OLS. Cluster robust standard errors are reported at the establishment level in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.
Source: authors' own calculations from ONS ARDx and MES surveys.

**Table 5: Moderation effects of family ownership by sub-groups**

| Dependent variable: Ln (GVA per worker) | (1) SMEs | (2) Large | (3) Manufacturing | (4) Services |
|---|---|---|---|---|
| Management practice score | 0.700*** | 0.578*** | 0.494*** | 0.751*** |
| | (0.115) | (0.206) | (0.146) | (0.136) |
| Management practice score× firm owned but not run by family | -0.295* | -0.573 | -0.316 | -0.231 |
| | (0.169) | (0.487) | (0.234) | (0.222) |
| Management practice score× firm owned and run by family | -0.279** | -0.087** | -0.286 | -0.316** |
| | (0.133) | (0.330) | (0.195) | (0.159) |
| Ln (employment) | -0.071** | -0.027 | -0.028* | -0.069** |
| | (0.012) | (0.022) | (0.015) | (0.009) |
| Ln (capital stock per worker) | 0.125*** | 0.147*** | 0.129*** | 0.136*** |
| | (0.006) | (0.011) | (0.009) | (0.009) |
| Firm owned and run by family | 0.051 | -0.20 | -0.072 | 0.080 |
| | (0.087) | (0.242) | (0.131) | (0.110) |
| Firm owned but not run by family | 0.111 | 0.399 | -0.125** | 0.104 |
| | (0.110) | (0.349) | (0.157) | (0.149) |
| Foreign ownership | 0.200*** | 0.209*** | 0.122*** | 0.266*** |
| | (0.030) | (0.045) | (0.037) | (0.036) |
| Company status | 0.392*** | 0.296*** | -0.052 | 0.395*** |
| | (0.048) | (0.067) | (0.281) | (0.041) |
| Export status | 0.115*** | 0.131*** | 0.024 | 0.194*** |
| | (0.024) | (0.053) | (0.032) | (0.029) |
| Ln (firm age) | 0.061*** | 0.053*** | 0.028*** | 0.081*** |
| | (0.103) | (0.032) | (0.024) | (0.018) |
| Year FE | Yes | Yes | Yes | Yes |
| Region FE | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes |
| N | 9711 | 2854 | 3536 | 7961 |
| R-sq | 0.317 | 0.357 | 0.479 | 0.376 |
| Fisher p-value | 0.360** | | -0.030 | |

Notes: Column (1) is based on the subsample of SMEs, while column (2) focuses on large firms. Column (3) presents results for firms in manufacturing sector, and column (4) for firms in services sector. Fisher p-value is calculated by conducting Fisher's permutation test, which tests the difference in the moderating effect of family management between two sample groups. A significant p-value means there is a statistically significantly difference between two groups. All models are estimated using OLS. Cluster robust standard errors are reported at the establishment level in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Source: authors' own calculations from ONS ARDx and MES surveys.

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**Table A1: MES questionnaire items**

| No. | Question | Year of application |
|---|---|---|
| **Section 1 Continuous improvement** | | |
| 1 | In general, what was the most common response to problems faced within your business? | 2016, 2019, 2020 |
| | Score of section1= q1 | |
| **Section 2 Key performance indicators (KPI)** | | |
| 2 | How many key performance indicators (KPIs) did monitor? | 2016, 2019, 2020 |
| 3 | How frequently was progress against the key performance indicators (KPIs) reviewed by managers? | 2016, 2019, 2020 |
| 4 | How frequently was progress against the key performance indicators (KPIs) reviewed by non-managers? | 2016, 2019, 2020 |
| | Score of section 2 = (q2+q3+q4)/3 | |
| **Section 3 Targets** | | |
| 5 | Which of the following best describes the main timeframes for achieving targets? | 2016, 2019, 2020 |
| 6 | How easy or difficult was it to achieve these targets? | 2016, 2019, 2020 |
| 7 | Approximately what proportion of managers were aware of these targets? | 2016, 2019, 2020 |
| 8 | Approximately what proportion of non-managers were aware of these targets? | 2016, 2019, 2020 |
| 9 | What were performance bonuses for managers usually based on? | 2016, 2019, 2020 |
| 10 | What were performance bonuses for non-managers usually based on? | 2016, 2019, 2020 |
| | Score of section 3= (q5+q6+q7+q8+q9+q10)/6 | |
| **Section 4 Employment practice** | | |
| 11 | How were managers usually promoted? | 2016, 2019, 2020 |
| 12 | How were non-managers usually promoted? | 2016, 2019, 2020 |
| 13 | On average how many days training and development did managers undertake? | 2016, 2019, 2020 |
| 14 | On average how many days training and development did non-managers undertake? | 2016, 2019, 2020 |
| 15 | Which of the following best describes the timeframe that action was taken to address under-performance among managers? | 2016, 2019, 2020 |
| 16 | Which of the following best describes the timeframe that action was taken to address under-performance among non-managers? | 2016, 2019, 2020 |
| | Score of section 4=(q11+q12+q13+q14+q15+q16) /6 | |
| **Overall score = (section 1+ section 2+section 3+section 4) /4** | | |
| 17 | Approximately what proportion of managers within this business had a performance review? | 2016 |
| 18 | Approximately what proportion of non-managers within this business had a performance review? | 2016 |
| 19 | Who would normally make decisions over whether to recruit permanent full-time employees? | 2016 |

Note: We adjust the original score in 2016 to align with the scoring frame in 2020 as the two waves do not follow the same scoring frame.
Source: the Management and Expectation survey

**Table A2: Sample distribution by observation frequency**

| Observation Frequency | 2016 | 2019 | 2020 | Total |
|---|---|---|---|---|
| *MES data* | | | | |
| 1 time | 5449 | 0 | 0 | 5449 |
| 2 times | 0 | 10142 | 10142 | 20284 |
| 3 times | 2238 | 2238 | 2238 | 6714 |
| Total | 7687 | 12380 | 12380 | 32447 |
| *Merged data with ARDx* | | | | |
| 1 time | 3791 | 2178 | 887 | 6856 |
| 2 times | 350 | 2105 | 2105 | 4556 |
| 3 times | 385 | 385 | 385 | 1155 |
| Total | 4526 | 4664 | 3377 | 12567 |

Notes: This table presents the distribution of sample counts by observation frequency in the years 2016, 2019, and 2020. The first section represents MES data, while the second section corresponds to the dataset merged with ARD. The values indicate the number of observations appearing in each year.

Source: authors' own calculations from ONS ARDx and MES surveys.

**Table A3: Sample distribution by sub-groups**

| Sample group | Family-owned firms (1) | Non-family-owned firms (2) | Total (3) |
|---|---|---|---|
| ***MES data*** | | | |
| Overall sample | 20446 (63%) | 11972 (37%) | 32447 (100%) |
| SMEs | 6709 (66%) | 3470 (34%) | 10192 (31%) |
| Large firms | 13737 (62%) | 8502 (38%) | 22255 (69%) |
| Foreign-owned firms | 943 (26%) | 2715 (74%) | 3661 (11%) |
| Domestic firms | 13474 (65%) | 7210 (35%) | 20707 (64%) |
| Firms owned and run by family | 14010 (100%) | 0 | 14010 (43%) |
| Firms owned but not run by family | 6427 (100%) | 0 | 6427 (20%) |
| Manufacturing sector | 4304 (65%) | 2354 (35%) | 6660 (21%) |
| Services sector | 14055 (61%) | 8997 (39%) | 23074 (71%) |
| ***Merged data with ARDx*** | | | |
| Overall sample | 7503 (60%) | 5064 (40%) | 12567 (100%) |
| SMEs | 6412 (66%) | 3299 (34%) | 9711 (77%) |
| Large firms | 1091 (38%) | 1765 (62%) | 2856 (23%) |
| Foreign-owned firms | 476 (24%) | 1517 (76%) | 1992 (16%) |
| Domestic firms | 7027 (66%) | 3547 (34%) | 10573 (84%) |
| Firms owned and run by family | 5322 (100%) | 0 | 5322 (42%) |
| Firms owned but not run by family | 2177 (100%) | 0 | 2177 (13%) |
| Manufacturing sector | 2115 (60%) | 1421 (40%) | 3536 (28%) |
| Services sector | 4572 (57%) | 3389 (43%) | 7961 (63%) |

Note: The first part of this table covers the sample of MES survey data with missing values. This second part covers the sample that is the overlapping dataset obtained by merging ARDx with MES. In columns (1) and (2), the percentages in parentheses represent the share of observations in that column relative to the total in column (3). In column (3), the percentages in parentheses represent the share of observations for that subgroup relative to the total sample size.

Source: authors' own calculations from ONS ARDx and MES surveys.

**Table A4: Sample distribution by regions and industries**

| Sample group | Overall sample | | Family-owned | | |
|---|---|---|---|---|---|
| | N | Mean | N | Mean | % |
| | (1) | (2) | (3) | (4) | (5) |
| Total | 12567 | 0.639 | 7503 | 0.614 | 60% |
| ***Regions*** | | | | | |
| North East | 440 | 0.631 | 278 | 0.612 | 63% |
| North West | 1319 | 0.642 | 793 | 0.613 | 60% |
| Yorkshire and Humberside | 1147 | 0.635 | 752 | 0.612 | 66% |
| East Midlands | 1030 | 0.632 | 656 | 0.611 | 64% |
| West Midlands | 1184 | 0.633 | 724 | 0.609 | 61% |
| East | 1203 | 0.636 | 746 | 0.618 | 62% |
| London | 1349 | 0.656 | 693 | 0.631 | 51% |
| South East | 1841 | 0.649 | 1016 | 0.620 | 55% |
| South West | 1214 | 0.638 | 756 | 0.615 | 62% |
| Wales | 486 | 0.635 | 302 | 0.604 | 62% |
| Scotland | 1354 | 0.625 | 787 | 0.601 | 58% |
| ***Industries*** | | | | | |
| Agriculture and Natural Resources | 295 | 0.631 | 195 | 0.601 | 66% |
| Manufacturing | 3536 | 0.642 | 2115 | 0.619 | 60% |
| Construction | 988 | 0.583 | 765 | 0.570 | 77% |
| Trade and Services | 3625 | 0.628 | 2475 | 0.608 | 68% |
| Financial and Professional Services | 2714 | 0.654 | 1414 | 0.629 | 52% |
| Public Services and Health | 1079 | 0.685 | 381 | 0.675 | 35% |
| Other Industries | 330 | 0.618 | 158 | 0.597 | 48% |

Notes: This table is based on the merged dataset with ARDx. Column (1) and (3) represent the number of observations in each category, while (2) and (4) refer to the average management practices score within that category. Column (5) indicates the proportion of family-owned firms relative to the overall sample in each category. Regions are classified according to the ITL 1 level. Industries are categorized based on 2-digit SIC codes, where Agriculture and Natural Resources correspond to 01-03, 05-09, and 35-39; Manufacturing includes 10-33; Construction covers 41-43; Trade and Services encompass 45-47, 49-53, 55-56, and 90-93; Financial and Professional Services consist of 58-63, 64-66, 68-75, and 77-82; Public Services and Health correspond to 84-88; and Other Services are classified under 94-99. Source: authors' own calculations from ONS ARDx and MES surveys.

**Table A5: Summary statistics for management practice score**

| Sample group | N | Mean | SD |
|---|---|---|---|
| | (1) | (2) | (3) |
| *MES data* | | | |
| Overall sample | 32447 | 0.613 | 0.159 |
| Manufacturing sector | 6660 | 0.616 | 0.154 |
| Services sector | 23074 | 0.616 | 0.157 |
| SMEs | 10192 | 0.617 | 0.151 |
| Large firms | 22255 | 0.611 | 0.162 |
| Family-owned firms | 20446 | 0.591 | 0.161 |
| Non-family-owned firms | 11972 | 0.649 | 0.147 |
| Firms owned and run by family | 14010 | 0.584 | 0.161 |
| Firms owned but not run by family | 6427 | 0.607 | 0.159 |
| *Merged data with ARDx* | | | |
| Overall sample | 12567 | 0.639 | 0.149 |
| Manufacturing sector | 3536 | 0.642 | 0.145 |
| Services sector | 7961 | 0.645 | 0.145 |
| SMEs | 9711 | 0.616 | 0.151 |
| Large firms | 2856 | 0.717 | 0.110 |
| Family-owned firms | 7503 | 0.614 | 0.155 |
| Non-family-owned firms | 5064 | 0.676 | 0.131 |
| Firms owned and run by family | 5322 | 0.603 | 0.157 |
| Firms owned but not run by family | 2177 | 0.642 | 0.146 |
| *Un-merged data with ARDx* | | | |
| Overall sample | 19880 | 0.596 | 0.162 |
| Manufacturing sector | 3124 | 0.586 | 0.158 |
| Services sector | 15113 | 0.601 | 0.161 |
| SMEs | 481 | 0.626 | 0.144 |
| Large firms | 19399 | 0.595 | 0.162 |
| Family-owned firms | 12943 | 0.578 | 0.163 |
| Non-family-owned firms | 6908 | 0.630 | 0.155 |
| Firms owned and run by family | 8688 | 0.573 | 0.163 |
| Firms owned but not run by family | 4250 | 0.589 | 0.163 |

Notes: The first part presents summary statistics for the management practice score derived from the MES data. The MES data includes some missing values. The second part provides summary statistics based on the overlapping dataset obtained by merging ARDx with MES. The third part is based on un-merged MES data with ARDx. In both panels: Column (1) reports the number of observations in each sample group, Column (2) shows the mean management practice score, and Column (3) presents the standard deviation of the management practice score. Source: authors' own calculations from ONS ARDx and MES surveys.

**Table A6: Correlation matrix**

|  | Ln (GVA per worker) | Ln (capital stock per worker) | Ln (employment) | Management score | Company status (D) | Family ownership (D) | Foreign ownership (D) | Export status (D) | Ln (firm age) |
|---|---|---|---|---|---|---|---|---|---|
| Ln (GVA per worker) | 1 | | | | | | | | |
| Ln (capital stock per worker) | 0.346*** | 1 | | | | | | | |
| Ln (employment) | -0.104*** | -0.076*** | 1 | | | | | | |
| Management practice score | 0.071*** | 0.019** | 0.403*** | 1 | | | | | |
| Company status (D) | 0.234*** | 0.034** | -0.048*** | 0.013 | 1 | | | | |
| Family ownership (D) | -0.062*** | -0.045*** | -0.279*** | -0.203*** | 0.252*** | 1 | | | |
| Foreign ownership (D) | 0.212*** | 0.111*** | 0.218*** | 0.183*** | 0.135*** | -0.317*** | 1 | | |
| Export status (D) | 0.192*** | 0.156*** | -0.024*** | 0.067*** | 0.204*** | -0.030*** | 0.249*** | 1 | |
| Ln (firm age) | 0.030*** | 0.043*** | 0.232*** | 0.044*** | -0.110*** | -0.070*** | 0.082*** | 0.137*** | 1 |

Note: Significance levels: *** for $p < 0.01$, and ** for $p < 0.05$. Dummy variables are denoted as D in parentheses.

Source: authors' own calculations from ONS ARDx and MES surveys.

**Table A7: The effect of management practices on productivity by sub-scores**

| Dependent variable: Ln (GVA per worker) | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Continuous improvement | 0.229*** | | | |
| | (0.064) | | | |
| KPIs | | 0.218*** | | |
| | | (0.068) | | |
| Targets | | | 0.166*** | |
| | | | (0.072) | |
| Employment practice | | | | 0.275*** |
| | | | | (0.061) |
| Ln (employment) | -0.038*** | -0.045*** | -0.037*** | -0.057*** |
| | (0.007) | (0.008) | (0.007) | (0.008) |
| Ln (capital stock per worker) | 0.134*** | 0.134*** | 0.134*** | 0.134*** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| Family ownership | -0.108*** | -0.106*** | -0.109*** | -0.111*** |
| | (0.019) | (0.019) | (0.019) | (0.019) |
| Foreign ownership | 0.220*** | 0.220*** | 0.223*** | 0.222*** |
| | (0.025) | (0.025) | (0.025) | (0.025) |
| Company status | 0.389*** | 0.382*** | 0.390*** | 0.378*** |
| | (0.040) | (0.040) | (0.040) | (0.040) |
| Export status | 0.127*** | 0.124*** | 0.127*** | 0.126*** |
| | (0.021) | (0.021) | (0.021) | (0.021) |
| Ln (firm age) | 0.055*** | 0.054*** | 0.053*** | 0.059*** |
| | (0.014) | (0.014) | (0.014) | (0.014) |
| Year FE | Yes | Yes | Yes | Yes |
| Region FE | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes |
| N | 12567 | 12567 | 12567 | 12567 |
| R-sq | 0.354 | 0.353 | 0.352 | 0.355 |

Notes: All columns are estimated using OLS. Cluster robust standard errors at the establishment level are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Source: authors' own calculations from ONS ARDx and MES surveys.

**Table A8: Robustness checks for baseline regression**

| Dependent variable: | Ln (turnover per worker） | TFP | Ln (GVA per worker) | Ln (GVA per worker) |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | OLS | OLS | LP | FE |
| Management score | 0.229*** | 0.290*** | 0.526*** | 0.298** |
| | (0.037) | (0.052) | (0.002) | (0.151) |
| Ln (employment) | -0.036*** | | -0.039*** | -0.445*** |
| | (0.005) | | (0.004) | (0.083) |
| Ln (capital stock per worker) | 0.056*** | | 0.087*** | 0.051*** |
| | (0.003) | | (0.007) | (0.008) |
| Ln (intermediate input) | 0.479*** | | | |
| | (0.009) | | | |
| Family ownership | -0.042*** | -0.069*** | -0.072*** | -0.050 |
| | (0.012) | (0.018) | (0.005) | (0.062) |
| Foreign ownership | 0.151*** | 0.177*** | 0.249*** | -0.025 |
| | (0.015) | (0.025) | (0.009) | (0.067) |
| Company status | 0.214*** | 0.343*** | 0.403*** | 0.267** |
| | (0.025) | (0.040) | (0.005) | (0.131) |
| Export status | 0.069*** | 0.117*** | 0.143*** | -0.086 |
| | (0.013) | (0.022) | (0.003) | (0.057) |
| Ln (firm age) | 0.021** | 0.017 | 0.074*** | 0.038 |
| | (0.009) | (0.013) | (0.001) | (0.104) |
| Year FE | Yes | Yes | Yes | Yes |
| Region FE | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes |
| Firm FE | No | No | No | Yes |
| N | 12567 | 12567 | 12567 | 5711 |
| R-sq | 0.796 | 0.278 | - | 0.851 |

Notes: Column (1) provides an alternative form of the production function. In Column (2), OLS is used to estimate the relationship between management practice and TFP estimated by the LP method. Column (3) use LP method to estimate the production function including management practice and introduce intermediate inputs as a proxy for unobserved productivity shocks. Column (4) additionally controls firm-level fixed effect, including 2663 firms. Because we use an unbalanced panel, column (4) reduces the sample size after controlling for firm-level fixed effects. Cluster robust standard errors are reported at the establishment level in parentheses. Significance levels: *** for $p < 0.01$, ** for $p < 0.05$, and * for $p < 0.1$.
Source: authors' own calculations from ONS ARDx and MES surveys.

| Dependent variable: Ln (GVA per worker) | (1) First stage | (2) Second stage | (3) First stage | (4) Second stage |
|---|---|---|---|---|
| Management practice score | | 0.704*** | | 0.455*** |
| | | (0.151) | | (0.145) |
| Mean score | 0.854*** | | | |
| | (0.020) | | | |
| Lagged score | | | 0.883*** | |
| | | | (0.010) | |
| Ln (employment) | 0.038*** | -0.065*** | 0.001 | -0.059*** |
| | (0.001) | (0.010) | (0.001) | (0.017) |
| Ln (capital stock per worker) | 0.003*** | 0.132*** | 0.001 | 0.128*** |
| | (0.001) | (0.005) | (0.001) | (0.011) |
| Family ownership | -0.015*** | -0.100*** | -0.001 | -0.080** |
| | (0.003) | (0.019) | (0.003) | (0.039) |
| Foreign ownership | 0.020*** | 0.212*** | 0.001 | 0.243*** |
| | (0.003) | (0.025) | (0.003) | (0.046) |
| Company status | 0.022*** | 0.373*** | -0.003 | 0.241*** |
| | (0.006) | (0.040) | (0.005) | (0.093) |
| Export status | 0.017*** | 0.117*** | 0.004 | 0.095** |
| | (0.004) | (0.022) | (0.003) | (0.045) |
| Ln (firm age) | -0.012*** | 0.062*** | 0.004 | 0.068** |
| | (0.002) | (0.014) | (0.002) | (0.031) |
| Year FE | Yes | Yes | Yes | Yes |
| Region FE | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes |
| N | 12567 | 12567 | 2432 | 2432 |
| R-sq | | 0.118 | | 0.103 |
| Kleibergen-Paap rk LM statistics | 779.124 | | 613.2 | |
| P-value | 0.000 | | 0.000 | |
| Cragg-Donald Wald F statistics | 1915.24 | | 9705.25 | |

Notes: Columns (1) and (2) present estimations using two-stage least squares (2SLS) with instrumental variables, which are the mean scores for the year, 2-digit industry, and ITL-1 region. Column (1) reports the first stage, while Column (2) reports the second stage. Columns (3) and (4) also utilize 2SLS, with lagged management practice scores as instrumental variables. Column (3) presents the first stage, and Column (4) presents the second stage. The p-value for the LM test for under-identification and the F-statistic for weak identification are reported. Cluster robust standard errors are reported at the establishment level in parentheses. Significance levels: *** for $p < 0.01$, ** for $p < 0.05$, and * for $p < 0.1$.

Source: authors' own calculations from ONS ARDx and MES surveys.

**Table A9: 2SLS results**

**Table A10 Robustness checks for moderation effect (Bootstrap)**

| Dependent variable: Ln (GVA per worker) | (1) | (2) |
|---|---|---|
| Management score | 0.672*** | 0.682*** |
| | (0.100) | (0.099) |
| Management score× family ownership | -0.243** | |
| | (0.115) | |
| Management score× firm owned but not run by family | | -0.280* |
| | | (0.155) |
| Management score× firm owned and run by family | | -0.261** |
| | | (0.117) |
| Ln (employment) | -0.058*** | -0.059*** |
| | (0.008) | (0.008) |
| Ln (capital stock per worker) | 0.133*** | 0.133*** |
| | (0.005) | (0.005) |
| Family ownership | 0.054 | |
| | (0.078) | |
| Firm owned but not run by family | | 0.043 |
| | | (0.080) |
| Firm owned and run by family | | 0.116 |
| | | (0.102) |
| Foreign ownership | 0.213*** | 0.204*** |
| | (0.025) | (0.025) |
| Company status | 0.381*** | 0.384*** |
| | (0.040) | (0.039) |
| Export status | 0.122*** | 0.120*** |
| | (0.020) | (0.022) |
| Ln (firm age) | 0.059*** | 0.061*** |
| | (0.013) | (0.014) |
| Year | Yes | Yes |
| Region | Yes | Yes |
| Industry | Yes | Yes |
| N | 12567 | 12567 |
| R-sq | 0.357 | 0.357 |

Notes: Columns (1) and (2) are estimated using OLS, with bootstrapped standard errors reported in parentheses, clustered at the establishment level. The bootstrap procedure is based on 1,000 replications. Significance levels: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Source: authors' own calculations from ONS ARDx and MES surveys.

**Table A11: Robustness checks for moderation effect (Bayes estimation)**

| Dependent variable: Ln (GVA per worker) | | |
|---|---|---|
| | (1) | (2) |
| Management score | 0.687 (0.022) | 0.673 (0.049) |
| | [0.648, 0.731] | [0.585, 0.739] |
| Management score× family ownership | -0.244 (0.013) | |
| | [-0.271, -0.222] | |
| Management score× firm owned but not run by family | | -0.219 (0.053) |
| | | [-0.308, -0.110] |
| Management score× firm owned and run by family | | -0.244 (0.043) |
| | | [-0.340, -0.161] |
| Ln (employment) | -0.057 (0.004) | -0.061 (0.007) |
| | [-0.063, -0.052] | [-0.073, -0.048] |
| Ln (capital stock per worker) | 0.134 (0.004) | 0.134 (0.004) |
| | [0.123, 0.136] | [0.127, 0.143] |
| Family ownership | 0.048 (0.007) | |
| | [0.033, 0.062] | |
| Firm owned but not run by family | | 0.034 (0.031) |
| | | [-0.025, 0.094] |
| Firm owned and run by family | | 0.075 (0.035) |
| | | [0.012, 0.134] |
| Foreign ownership | 0.218 (0.013) | 0.205 (0.024) |
| | [0.194, 0.245] | [0.332, 0.418] |
| Company status | 0.372 (0.019) | 0.378 (0.023) |
| | [0.329, 0.405] | [0.332, 0.418] |
| Export status | 0.112 (0.014) | 0.121 (0.011) |
| | [0.084, 0.137] | [0.037, 0.079] |
| Ln (firm age) | 0.060 (0.005) | 0.060 (0.011) |
| | [0.050, 0.069] | [0.037, 0.079] |
| Year | Yes | Yes |
| Region | Yes | Yes |
| Industry | Yes | Yes |
| N | 12567 | 12567 |

Notes: Columns (1) and (2) are estimated using Bayesian linear regression, where posterior means are reported, which are similar to OLS estimators. Posterior standard deviations, analogous to standard errors in OLS, are provided in parentheses. The 95% confidence intervals are presented in square brackets.
Source: authors' own calculations from ONS ARDx and MES surveys.

**Table A12: Overall moderation effect of family ownership by sub-groups**

| Dependent variable: Ln (GVA per worker) | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | SMEs | Large | Manufacturing | Services |
| Management score | 0.695*** | 0.568*** | 0.485*** | 0.741*** |
| | (0.116) | (0.206) | (0.146) | (0.137) |
| Management practice score× family ownership | -0.270** | -0.060 | -0.280 | -0.269* |
| | (0.129) | (0.305) | (0.180) | (0.155) |
| Ln (employment) | -0.069*** | -0.024 | -0.027* | -0.067*** |
| | (0.012) | (0.022) | (0.015) | (0.009) |
| Ln (capital stock per worker) | 0.125*** | 0.147*** | 0.129*** | 0.136*** |
| | (0.006) | (0.011) | (0.009) | (0.007) |
| Family ownership | 0.064 | -0.039 | -0.082 | 0.079 |
| | (0.085) | (0.222) | (0.121) | (0.079) |
| Foreign ownership | 0.209*** | 0.223*** | 0.128*** | 0.277*** |
| | (0.030) | (0.046) | (0.036) | (0.036) |
| Company status | 0.390*** | 0.288*** | -0.050 | 0.390*** |
| | (0.048) | (0.067) | (0.281) | (0.041) |
| Export status | 0.117*** | 0.131*** | 0.023 | 0.198*** |
| | (0.023) | (0.053) | (0.032) | (0.029) |
| Ln (firm age) | 0.059*** | 0.050*** | 0.027*** | 0.080*** |
| | (0.015) | (0.032) | (0.024) | (0.018) |
| Year FE | Yes | Yes | Yes | Yes |
| Region FE | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes |
| N | 9711 | 2854 | 3536 | 7961 |
| R-sq | 0.316 | 0.477 | 0.184 | 0.375 |

Notes: Column (1) is based on the subsample of SMEs, while column (2) focuses on large firms. Column (3) presents results for firms in manufacturing sector, and column (4) for firms in services sector. All models are estimated using OLS. Cluster robust standard errors are reported at the establishment level in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.
Source: authors' own calculations from ONS ARDx and MES surveys.

**Table A13: Divided moderation effect of family ownership by sub-groups**

| Dependent variable: Ln (GVA per worker) | | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| | Manufacturing SMEs | Services SMEs | Services large firms |
| Management score | 0.516*** | 0.796*** | 0.671*** |
| | (0.160) | (0.152) | (0.244) |
| Management score× firm owned but not run by family | -0.393 | -0.221 | -0.692 |
| | (0.258) | (0.218) | (0.603) |
| Management score× firm owned and run by family | -0.290 | -0.302*** | -0.073 |
| | (0.210) | (0.170) | (0.401) |
| Ln (employment) | -0.044** | -0.077** | -0.046** |
| | (0.019) | (0.014) | (0.023) |
| Ln (capital stock per worker) | 0.126*** | 0.126*** | 0.149*** |
| | (0.009) | (0.007) | (0.013) |
| Firm owned and run by family | 0.067 | 0.062 | -0.093 |
| | (0.138) | (0.111) | (0.294) |
| Firm owned but not run by family | 0.141 | 0.074 | 0.455 |
| | (0.168) | (0.141) | (0.426) |
| Foreign ownership | 0.102*** | 0.288*** | 0.236*** |
| | (0.041) | (0.043) | (0.056) |
| Company status | -0.030 | 0.406*** | 0.306*** |
| | (0.281) | (0.049) | (0.068) |
| Export status | 0.039 | 0.181*** | 0.161** |
| | (0.034) | (0.032) | (0.064) |
| Ln (firm age) | 0.039 | 0.073*** | 0.079** |
| | (0.026) | (0.018) | (0.036) |
| Year FE | Yes | Yes | Yes |
| Region FE | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes |
| N | 3007 | 6704 | 2205 |
| R-sq | 0.171 | 0.348 | 0.459 |

Notes: Column (1) is based on the subsample of SMEs in manufacturing sector, column (2) focuses on SMEs in services sector, and column (3) covers large firms in services sector. All models are estimated using OLS. Cluster robust standard errors are reported at the establishment level in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Source: authors' own calculations from ONS ARDx and MES surveys.