



“Channels of Managerial Capital Accumulation – A Framework and New Evidence from UK Microdata”

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Channels of Managerial Capital Accumulation – A Framework and New Evidence from UK Microdata

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Organisational capital is usually estimated indirectly, from workforce data or as residual from balance sheets. In this paper, we focus on a particular subset of organisational capital, managerial capital. We first discuss a comprehensive framework for measuring the contribution of possible channels of managerial capital accumulation and how they could be measured from existing UK microdata sources. We then show novel evidence on the distribution of management scores in Great Britain from the Management and Expectations Survey 2020 and use it to assess the relative importance of these different accumulation channels. Our preliminary empirical analysis suggests a high correlation between the different channels of managerial capital accumulation, which is a blessing and a curse: it means each investment measure is a decent proxy when others are not available but underlines the importance of linked data when accounting for the importance of each.

¹ Affiliation: Office for National Statistics (ONS). The Management and Expectations Survey 2020 was developed in collaboration with the Economic Statistics Centre of Excellence (ESCoE) – Nick Bloom, Paul Mizen, Rebecca Riley and John Van Reenen deserve particular mention. We are also grateful to Kyle Jones for support in the early stages of this project, and to numerous ONS colleagues for sharing their deep survey knowledge. We gratefully acknowledge funding from ESRC grant ES/S012729/1. The views are the authors' own and do not necessarily reflect those of the Office for National Statistics.
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1. Missing channels of organisational capital accumulation

Several existing papers try to estimate the accumulation of organisational capital from the occupational structure of a firm. But this evidence is only indirect, and human capital is only one channel of organisational capital accumulation. In this paper, we focus on one particular subcategory of organisational capital, managerial capital. We first propose a framework for thinking about all channels of managerial capital accumulation jointly and discuss advantages and disadvantages of existing UK firm microdata sources for measuring each. We then present new evidence from the Management and Expectations Survey (MES) 2020 about the distribution of management practices, a more direct measure of managerial capital, across British firms and then use the MES 2020 to assess the relative importance of different channels for managerial capital accumulation. While the results for now are highly preliminary, they suggest strong correlations between the different channels of managerial capital accumulation. As a result, any one measure is a decent proxy for managerial capital in an environment where good firm-level data is scarce. Likewise, however, the strong correlation means that the individual contribution of any one channel cannot be disentangled without measuring all others.

The rest of the paper is organised as follows. Section 2 proposes a framework for thinking about channels of investment in managerial capital. Section 3 presents the design of MES 2020 and draws a picture of management practices across the UK in 2020. Section 4 discusses existing UK microdata sources of managerial capital estimates. Section 5 contains preliminary results from an empirical investigation of the relative contribution of the different channels. A final Section 6 concludes.

2. A framework for thinking about organisational capital accumulation

Organisational capital is widely thought to be an important determinant of firm success. The literature surveyed below has consistently found positive links between organisational

capital (narrowly or broadly defined) and firm growth, productivity, and survival, regardless of the methodological approach employed.

However, the concept of organisational capital remains somewhat elusive. The term “organisational capital” is generally taken to mean a stock of ideas and knowledge relating to the structure and know-how of the organisation, and might relate to supply chains, customer relations, or internal policies.

A related literature examines “management practices” (for instance, Bloom and van Reenen, 2007; Bloom et al., 2013; Bloom et al., 2017; ONS, 2021), which we see as a subset of the broader term “organisational capital”. Management practices relate more explicitly to the internal HR and management processes, such as training, employment decisions, target setting and monitoring, and so on. “Managerial capital” is the asset which “management practices” aim to measure, and we consider a subset of “organisational capital”.

Another related literature, albeit more tangentially, is human capital. Organisational capital can arise due to human capital – that is, people with human capital can generate organisational capital. But they are distinct and not interchangeable. The crucial difference here is that human capital is ‘owned’ by the individual, while organisational capital is ‘owned’ by the business. If the CEO of a business leaves, she takes with her her human capital, but the business retains its organisational know-how (see also Ludewig and Sadowski (2009) and Black and Lynch (2005) for different theoretical models of organisational capital).

The flows of organisational capital go by yet other names. In the intangible assets literature, investments in organisational capital are sometimes known as “business process improvements”. The “improvements” here makes clear this is a flow, relating to a stock of “business processes”, or interchangeably “organisational capital”.

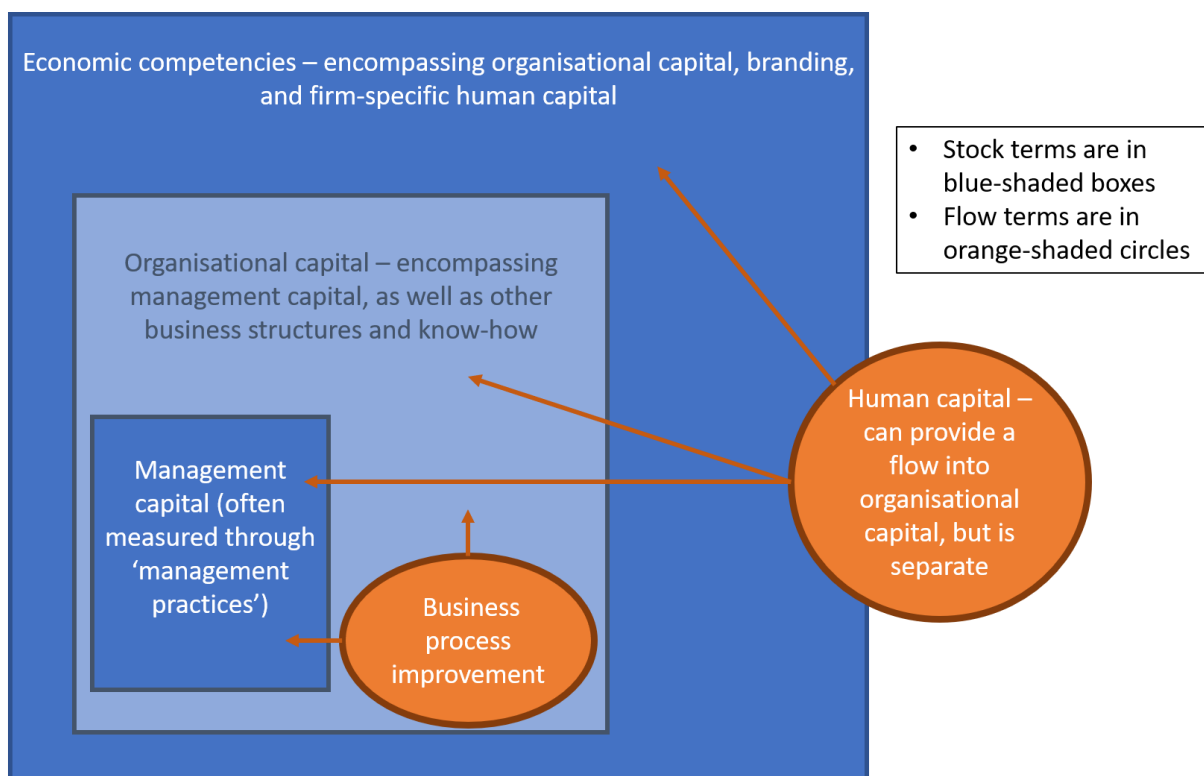
In the intangible assets literature, organisational capital is a subset of a broader group of intangible assets known as “economic competencies”, along with branding and firm-specific human capital (training). Some studies use measures of investment which we think

correspond better to this very wide interpretation of ‘business knowledge’, such as Li, Nirei and Yamana (2018) and Lev and Radhakrisnan (2005). For instance, Li, Nirei and Yamana (2018) use expenditure on ‘sales, general and administrative’ (SGA) to proxy for investment in organisational capital, but given the very broad scope of SGA expenditures, we see this as a better proxy for investment in “economic competencies” than “organisational capital”.

We mainly use “organisational capital” in this paper to mean the asset most broadly, with data relating to management practices, human capital, and investment in intangible assets treated separately. Figure 1 provides an overview of the way we interpret these terms.

Having fixed terms, we turn to the measurement of organisational capital. It is again useful to distinguish between stocks and flows.

Figure 1: Definitions relating to organisational capital employed in this paper



Squicciarini and Le Mouel (2012) outline three methods for measuring organisational capital. The first two are stock measures, and the latter is a flow measure:

1. Survey measures: gathering information from companies about their organisational practices, before trying to place a value on these practices.
2. Effect on firm performance: estimating the value of organisational capital based on assumed production functions and observed firm performance.
3. Costs of production: Estimating the costs sunk into creating organisational capital.

Surveys of management practices, such as the World Management Survey and the Management and Expectations Survey, fall into the first category, although not all such studies try to put a value on the management practices. This approach generates useful firm-level measures which can be used for descriptive analysis of the distribution of managerial capital (ONS 2021a, ONS2021b), and its links with other economic variables of interest, such as productivity. It does not, in general, identify the channel through which that managerial capital is generated, and the questions are generally too narrow to cover all types of organisational capital.

Another strategy is to use financial data on companies to infer the value of organisational capital. In the simplest case, the market capitalisation of a business can be thought of as reflecting both the tangible assets owned by the business, and intangible assets embodied in the business – the latter constitute organisational capital, broadly defined. For instance, Eisfeldt and Papaikolaou (2009) argue that businesses with more organisational capital will have a higher Tobin's Q. Lev et al. (2013) estimate organisational capital based on the surplus profits in observed firm performance, compared with predicted profits based on past performance. Miyagawa and Kim (2008) use excess returns on investment in complementary assets like R&D and advertising. These approaches generally require estimating a firm's production function, which is challenging, and makes it difficult to identify the channels of either accumulation or return on organisational capital.

The intangible assets literature largely follows the third approach outlined above, estimating investment and accumulating it using the Perpetual Inventory Method (PIM) to estimate a capital stock of the asset. This is typically done at industry and economy level, rather than firm-level, given data challenges. This approach was introduced in the seminal work of

Corrado, Hulten and Sichel (2005) and developed for the UK by Goodridge, Haskel and Wallis (2014, 2016) amongst others.

This literature treats organisational capital and the various other intangible assets as produced fixed assets; this means they are created through the production process. That process can either be within the firm that goes on to use it (so called 'own-account investment'), or in another firm who then sells the asset (so called 'purchased investment'). The purchased investments are typically expenditures on management consultancy services, often found from National Accounts data on business expenditure by product. The own-account investments are estimated using a sum of costs approach, as used widely in this area. This involves identifying occupations that are thought to create the asset in-house, and the fraction of time they spend doing so. That fraction of their wages is capitalised, and a set of adjustments added to account for non-labour costs. The assumptions used in the literature stem largely from Corrado, Hulten and Sichel (2005), who use an "admittedly arbitrary" 20% of the wage bill of all managers. Martin (2019) tests the assumption that only managers generate in-house organisational capital and that they spend about 20% of their time doing so. Generally, this assumptions seems to be supported.

Gorzig, Piekkola and Riley (2011) compare the wages of occupations with their contribution to firm revenue in the UK and other European countries, to estimate the amount of their time spent creating long-lasting assets. They find support for the 20% figure used in the literature as described above. This also links to the balance sheet method, since it implies that the value of 'missing assets' can be found by residual once other explanatory factors are considered.

Not all organisational capital or management capital arises as a result of conscious investment though. Some is learnt through business operations, and interactions with customers and suppliers. Some is inherited from staff who have worked in other organisations, who share their ideas and experiences. Some is developed through the use of capital assets, especially types of customer or staff management software.

Most studies of organisational capital treat different channels in isolation. We propose a new taxonomy of organisational capital accumulation, which we believe helps to facilitate thinking about these channels jointly. Our taxonomy defined in Table 1.

Table 1: Channels of managerial capital accumulation

1.	<i>Invested</i>
	a. Direct purchases
	b. Own-account creation
2.	<i>Inherited</i>
	a. Labour-embedded
	b. Capital-embedded
3.	<i>Learnt</i>
	a. Vertical learning (along the supply chain)
	b. Horizontal learning (within industry)

Organisational capital is either the fruit of direct investment, through purchases from other firm or creation within the firm; embedded in other productive assets of the business, in the form of its labour force or its capital assets; or acquired through a process of learning either along the supply chain or through the interactions with competitors.

The papers cited so far have emphasised different aspects of direct purchases (1.a), own-account creation (1.b) and labour-embedded (2.a). creation of organisational capital. In the following sections, we discuss what evidence exists from UK microdata sources. However, some channels are inherently trickier to measure than others. Learning, for instance, whether it happens along the supply chain or from competitors, can only be inferred indirectly at present.

Even though not all channels in the framework are directly observable at present, we argue that it is nonetheless useful: it allows to be more precise about the meaning of the residuals, and offers concrete avenues for future survey design.

3. The Management and Expectations Survey 2020

3.1. Sample design

The Management and Expectations Survey (MES) is a voluntary, experimental business survey administered by the Office for National Statistics. A precursor focused on the manufacturing sector only (the Management Practices Survey, MPS). The first full wave of the MES launched in 2017 with the aim of gathering information on management practices employed by British firms in 2016. A second wave followed in 2020. MES collects a range of data on the management practices of businesses and their expectations for future years.

MES 2020 sample was selected from three sources: MES 2017 respondents, Annual Business Survey (ABS) 2020 respondents and the Inter-Departmental Business Register (IDBR). Sampling from previous MES and ABS respondents allows for linked longitudinal and productivity analysis, while additional random sampling from the IDBR increased the sample size and enabled the sample to be optimised with respect to industry and firm size coverage. The MES 2017 sample was a subset from the ABS, to enable linked productivity analysis.

MES 2020 includes some methodological innovations over the 2017 survey. Due to the timing of the 2020 survey, coinciding with the coronavirus (COVID-19) pandemic, the survey was changed from a traditional paper questionnaire to an electronic questionnaire. MES 2020 also included novel questions around homeworking, online sales and supply chain disruptions.

A firm's industry, region and employment were taken from the IDBR at the time of drawing the sample. The Standard Industrial Classification (SIC) 2007 code on the IDBR, available at five-digit level, determines the firm's industry. Region is classified by Nomenclature of

Territorial Units for Statistics (NUTS)² level 1 for the Great Britain. Employment is used to categorise firms by size, with four size bands used: 10-19, 20-49, 50-250, 250+. MES does not sample microbusinesses (firms with less than 10 employees) for a variety of reasons. Some evidence suggests that personnel management questions for microbusinesses are not reliable and that the burden of the survey is too great.

As MES is not a mandatory survey, sampling from the ABS helps increase the response rate, as these businesses are familiar with completing surveys. To investigate response bias, we used OLS regressions to predict sample response from firm observable characteristics, including 2016 management scores for previous MES respondents (see Table A1.1 in Appendix A1). Coefficients are generally close to zero and insignificant, and the R² is low across specifications.

In 2017, the response rate was 37%, producing around 9,000 responses. In 2020, the response rate was 24%, resulting in roughly 12,000 useable responses.³ MES has a broad coverage of industry capturing businesses within production and services. However, it excludes parts of sector K and A (Finance and Agriculture, Forestry and Fishing) of SIC due to lack of coverage from the ABS.

3.2. Management practices measures in MES 2020

The Management and Expectations Survey (MES) provides the most direct evidence to date of the distribution of managerial capital in Great Britain, as measured by the adoption of structured management practices. MES 2020 measures management practices along four dimensions: targets, key performance indicators (KPIs), continuous improvement and employment practices.

² The NUTS system has since been replaced by the International Territorial Levels (ITL), with little change in coverage.

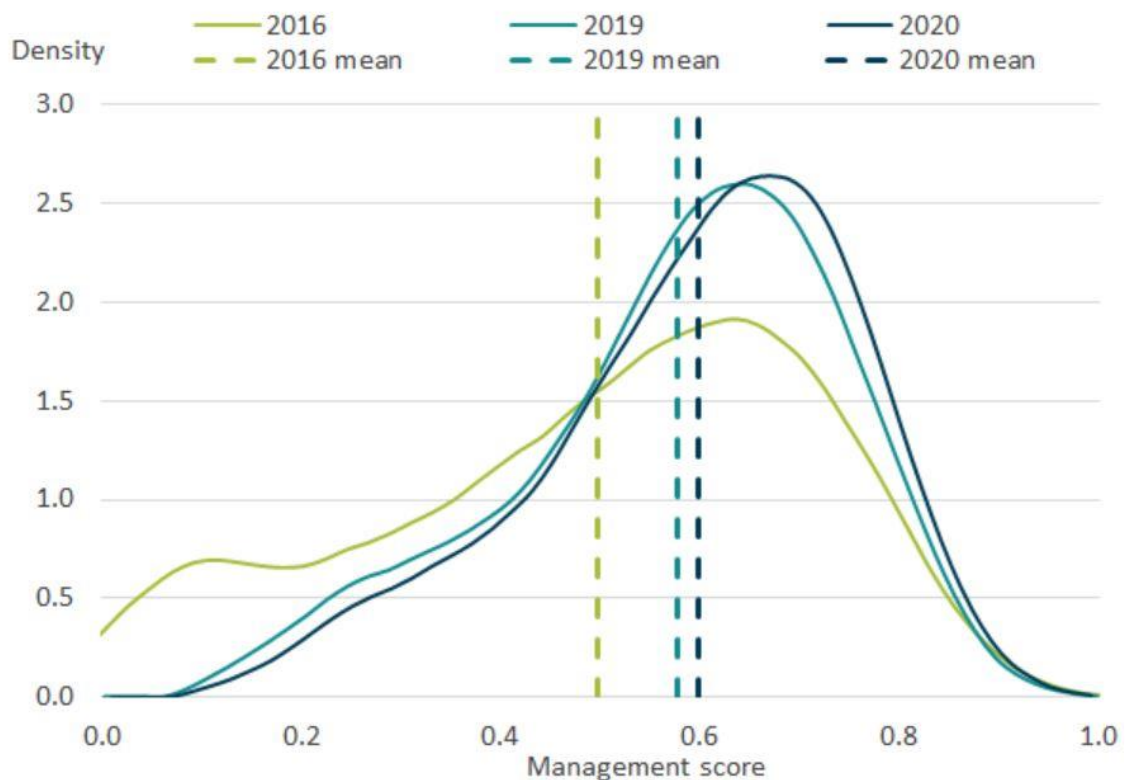
³ The response rate is very much in line with the other large, voluntary ONS business survey collected in the pandemic, the Business Insights and Conditions Survey (BICS).

In the MES, the targets score assesses how targets are set, tracked and reviewed. The KPI category includes questions on the number of KPIs used by a firm and the frequency at which they are monitored. Continuous improvement is assessed via a single question on how firms react and adapt to unexpected situations. Employment practices measure the processes relating to hiring, management and promotion of a firm's employees.

The overall management practices score used in most of the empirical specifications in this article is a simple arithmetic mean of the four category scores.

The MES 2020 questionnaire was developed by the ONS in collaboration with academic partners in the Economic Statistics Centre of Excellence (ESCoE) and is based on the earlier MES 2016, the Management Practices Survey (MPS) 2015 and their US equivalent, the Management and Organizational Practices Survey (MOPS).

Figure 2: Management practices in Great Britain, 2016-2020



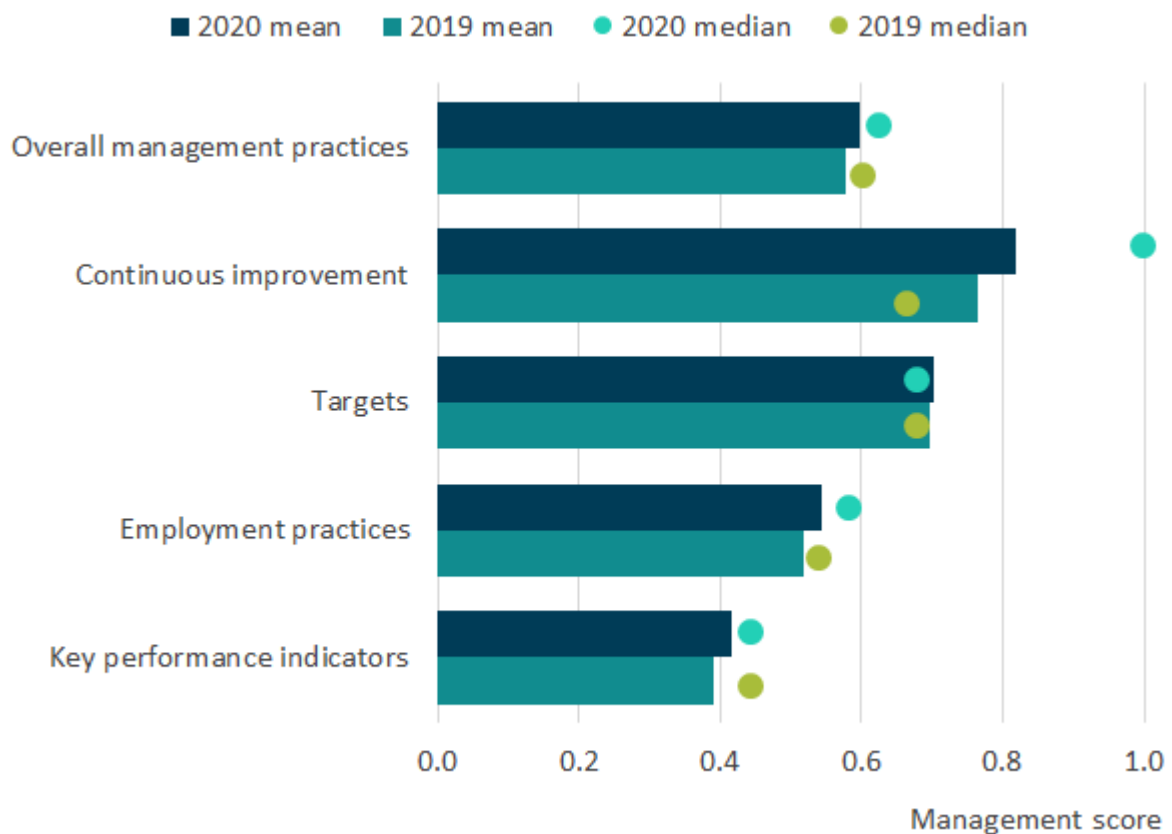
Source: ONS 2021a

3.3. The distribution of management practices in Great Britain, 2016-2020

Average management practices in Great Britain have improved slightly over the period 2016 to 2020, as shown in Figure 2. This is largely due to improvements among smaller, previously less well-managed firms bringing up the lower tail of the distribution.⁴

When broken down by category, the overall improvement in management score comes mostly from more widespread use of continuous improvement techniques, and to a lesser extent from the adoption of more structured employment practices. Targets and KPIs have moved less over time (see Figure 3).

Figure 3: Continuous improvement and employment practices drive overall changes



Source: ONS 2021a

⁴ Results are almost identical for the full sample and the linked sample at the firm level, suggesting that at least part of this improvement is driven by true within-firm increases in managerial capital. For more details, please consult the appendix A1.

Another notable feature of the data is that intra-industry and intra-regional variation in management practices dwarfs inter-industry and inter-regional variation. For a more comprehensive picture of the state of management practices in Great Britain in 2020 as well as a discussion of possible sample selection issues, please see the appendix and our earlier articles (ONS, 2021a, ONS 2021b).

4. Existing UK microdata sources of managerial capital accumulation channels

Currently there exist three major challenges for measuring and disentangling the channels of managerial capital accumulation. First, no single UK microdata source is set up to measure the accumulation of organisational capital. Therefore, we need to either look at channels in isolation (the existing approach) or link surveys (and either use a small and selected sample at the firm level, or aggregate to a higher level for consistent units of observation over time). Second, because accumulation of organisational capital is hard to observe and a relatively new object of study in applied research, some channels cannot be measured directly, but proxied at best. Third, because organisation capital accumulation is an input choice of the firm, additional identifying assumptions need to be satisfied in order to establish the causal effects of organisational capital contributions to the firm.⁵

In addition to the MES, several other UK business surveys capture aspects of the framework outlined in Section 2. This section discusses the most important of these, namely the Annual Purchases Survey, the Annual Survey of Hours and Earnings, the E-commerce Survey, and the Employer Skills Survey. The following section links these surveys to the MES at a detailed industry-size level and presents preliminary findings from a decomposition across measured channels of managerial capital accumulation.

Table 2 summarises the variables we use in the empirical analysis, their source, definition, and what years they are available for (over the period for which we have MPS/MES data).

⁵ The last point is beyond the scope of this paper. However, once managerial capital investments are measured correctly, the identification problem can be solved in ways analogous to other endogenous inputs. See De Loecker and Syverson (2021) for an overview.

4.1. Annual Purchases Survey

The Annual Purchases Survey (APS) was relaunched in 2016 after a decade-long hiatus. It collects very detailed breakdowns on business current expenditure, known as intermediate consumption in the National Accounting jargon. Intermediate consumption is expenditure on goods and services that are transformed or used up in the production process. The main purpose is to inform the compilation of the intermediate use table of the supply and use tables – a detailed matrix of products and industries.

The APS is sub-sampled from the Annual Business Survey (ABS), to enable data linkage and congruency testing. Like the ABS, the APS only covers the market sector – that is, not government or non-profits. It also excludes most of agriculture. It samples around 31-33,000 businesses annually, achieving a response rate of around 80% (in line with other ONS business surveys), yielding around 26,000 responses.

Among the goods and services that the APS collects data on is “head office and management consulting services”, corresponding to product 70 of the Classification of Products by Activity (CPA) revision 2.1. Given the many products to choose from, the selection of products asked on the questionnaire varies by industry. However, respondents can always add more products from a full list at the end of the questionnaire. When included in the main body of the question, the relevant question text is:

What was your expenditure on: head office and management consulting services?

Include:

- *public relations and communication services*
- *business management consulting services*

Exclude:

- *holding company services*
 - *construction project management services*
 - *accounting, bookkeeping and financial auditing services*
-

When it does not appear in the main body of the questionnaire, the business must include it under the following question:

What was your expenditure on: any other services?

Please refer to the list of additional Codes for Section D – Services at the end of this section and write the applicable codes in the boxes below.

From Codes for Section D – Services:

7000 Head office and management consulting services

The survey explicitly excludes capital investment, in line with its purpose. However, the meaning of ‘investment’ differs between business accounting, national accounting, and economic analysis. For our purposes, we consider these expenditures a type of ‘intangible investment’ but businesses need not consider it as such to record it here. That said, if they did consider it an investment, they might not record it here – this seems unlikely as it would not meet the requirements of capital investment in business accounting. It also excludes in-house expenses such as staff costs.

4.2. Annual Survey of Hours and Earnings

The Annual Survey of Hours and Earnings (ASHE) is a business survey run by ONS. It has been run every year since 2008, before which it was the New Earnings Survey, run in much the same way since the 1970s. It collects a range of data on pay and hours worked.

ASHE is a 1% sample of the working population, selecting all active National Insurance numbers ending with a certain combination of digits. The combination is the same every year, such that the respondents form a quasi-panel, with some additions from newly allocated National Insurance numbers every year, and some departures due to retirement, redundancy or death.

While it is employees that are sampled, employers respond to the survey about the sampled employee. This means that data is of generally higher quality and can be easily linked to other business data. However, it also means that much demographic data cannot be collected on the survey, since it is typically not known to the employer. Indeed, employees usually do not know they are sampled.

The business' industry is taken from the Inter-Departmental Business Survey (IDBR) at the time of survey dispatch. The occupation is 'coded' to the Standard Occupational Classification (SOC) using an automated matching software, and when that fails, by hand. We will rely on the occupation codes to identify managers, which are typically more difficult to code than other occupations given the range of unique job titles that can exist.

While the survey is mandatory, it achieves a response rate of around 70%, yielding around 180k responses per year. It covers all employees with National Insurance numbers, so includes government, but excludes the self-employed. Coverage of areas of the economy where other forms of payment (e.g. cash in hand) are more common will also be less well covered.

4.3. E-commerce Survey

The E-commerce Survey is run by ONS following international guidance, and much of the survey and questions are harmonised across Europe. It is a smaller (although still relatively large) business survey, run annually, to collect data on the e-commerce and digital activities of businesses.

It has a sample of around 11,000, covering most of the business economy. It largely excludes the public sector (section O), education (section P), health and social care (section Q), finance and insurance (section K), agriculture (section A), mining and quarrying (section B), arts and entertainment (section R), veterinary services (division 75), most personal and other services (most of section S). Prior to 2014, only businesses with 10 or more employees were sampled, but the sample size was increased (to the current level) and micro-businesses added in 2014. With a response rate of around 80% (which is typical for ONS business surveys) there are around 8,500 responses per year.

The survey measures the adoption and use of existing and emerging information and communication technologies (ICT) and e-commerce activity. Amongst this are questions relating to the use of various management software, including Customer Relationship

Management (CRM) software. It does not measure investment in (spending on) this software but does capture usage.

For instance, it includes questions on:

- Use of online invoicing
- Use of cloud computing services for a range of purposes, including:
- Finance or accounting software applications
- Customer Relations Management (CRM) software

4.4. Employer Skills Survey

The Employer Skills Survey (ESS) is run by three private research agencies (IFF Research, BMG Research and Ipsos MORI) on behalf of the Department for Education. It is a business survey covering all industries, but only businesses with 2 or more employees. It is sampled not through the IDBR (as for almost all ONS business surveys) but using private sector data, and with a top-up from the IDBR. This is because the IDBR does not have telephone numbers for many businesses, and ESS is run by telephone interview.

A large sample is collected, expecting a low response rate. Only around a third of the sample is successfully contacted, of which under half respond, giving an overall response rate of around 15%. In 2019, of nearly 600,000 sampled businesses, around 80,000 interviews were achieved. In 2017, including Scotland, the sample and achieved responses were higher, with a slightly lower response rate.

The survey runs every 2 years (on odd years, e.g. 2017, 2019). Since 2011 it has covered the whole of the UK, prior to which it was for England only. The 2019 survey excluded Scotland. Fieldwork takes place during the odd year, with data generally relating to the time of the interview or 'the past year'.

ESS collects a range of data on employment practices, skills, training, recruitment, and so on. For our purposes, questions on management and leadership skills are of interest.

Table 2: Summary of variables employed in analysis

<i>Variable</i>	<i>Source</i>	<i>Definition</i>	<i>Stock/Flow?</i>	<i>Coverage</i>
Management score 2016	MES ⁶	Arithmetic mean of subcategories	Stock	2015, 2016, 2019, 2020
Proportion of managers with a degree	MES	Dummy variable: 1 if above economy-wide median	Stock	2015, 2016, 2019, 2020
Proportion of non-managers with a degree	MES	Dummy variable: 1 if above economy-wide median	Stock	2015, 2016, 2019, 2020
Proportion of managers	MES	Ratio of number of managers to total employment	Stock	2015, 2016, 2019, 2020
Proportion of management services	APS	Ratio of head office and management consulting services expenditure to total services expenditure	Flow	2015, 2016, 2017, 2018
Development of management software/systems	E-Commerce	Dummy variable: 1 if firm develops management software/systems	Flow	2014, 2015, 2017, 2019
Support of management software/systems	E-Commerce	Dummy variable: 1 if firm supports managing software/systems	Flow	2014, 2015, 2017, 2019
Types of invoicing	E-Commerce	Dummy variable: 1 if firm uses electronic invoicing	Flow	2014, 2015, 2017, 2019

⁶ For 2015, this refers to MPS and covers the manufacturing sector only.

Table 2, continued: Summary of variables employed in analysis

<i>Variable</i>	<i>Source</i>	<i>Definition</i>	<i>Stock/Flow?</i>	<i>Coverage</i>
Support for office software	E-Commerce	Dummy variable: 1 if firm has support for office software	Stock	2014, 2015 2017, 2019
Maintenance of ICT infrastructure	E-Commerce	Dummy variable: 1 if firm maintains its ICT infrastructure	Flow	2014, 2015 2017, 2019
Internal development and/or support management software/systems	E-Commerce	Dummy variable: 1 if firm internally develops and/or supports managing software/systems	Flow	2014, 2015 2017, 2019
External development and/or support management software/systems	E-Commerce	Dummy variable: 1 if firm externally develops and/or supports managing software/systems	Flow	2014, 2015 2017, 2019
Weekly pay	ASHE	Logarithm of average weekly pay for all employment	Flow	2015, 2016, 2017, 2018, 2019, 2020
Senior management pay	ASHE	Average pay of employees included in group 1 of SOC 2010 ⁷	Flow	2015, 2016, 2017, 2018, 2019, 2020
Proportion of managers	ASHE	Ratio of managers to total employment	Stock	2015, 2016, 2017, 2018, 2019, 2020

⁷ SOC group 1 consists of managers, directors and senior officials.

5. Initial Estimates of Organisation Capital Decompositions

5.1. Necessity and validity of the industry-size cell approach

In an ideal world, we would be able to collect all relevant information concerning managerial capital accumulation in a single survey. Failing that, we would be able to link data across surveys at the firm level. The reality, at least in the UK however, is that this is at present not feasible. Table 3 shows sample overlaps at the firm level across the surveys described above, for a single year. These overlaps are even fewer once we link across waves, as we would need to do in order to examine changes over time. Moreover, due to the sampling rules that Office for National Statistics applies, the firms that are present in the sample overlaps are usually not representative of the UK economy. They are generally larger, more complex, and concentrated in particular sectors.⁸

Table 3: UK business survey overlaps are small and selected

[INSERT TABLE 3 HERE]

Therefore, in this paper we construct detailed industry-size cells (with size defined by employment), and weigh survey respondents within each cell to ensure they are representative of the total cell population. The data appendix provides additional detail about the construction of the cells, and some evidence that after weighing sampled firms are representative of their cell in terms of characteristics recorded on the Interdepartmental Business Register (IDBR).

5.2. Relative contributions of organisational capital channels

In this subsection we present our preliminary estimates. They present two main lessons: first, at the cell level investments via the various channels are correlated, leading to regression coefficients that suffer from omitted variable bias if we estimate them on

⁸ Osmotherly et al. (1996) provides guidance on how UK surveys could be designed to ease the burden on UK businesses.

separate surveys only. Second, however, because investments are correlated, for the purpose of prediction, estimating managerial capital off individual surveys only fares relatively well.

Table 4: OLS estimates of managerial capital investment channels, by survey source

VARIABLES	(1) MES	(2) ASHE	(3) APS	(4) Ecom
% managers with degree	0.0922** (0.0407)			
% of managers	-0.296* (0.155)			
% non-managers with degree	0.0972** (0.0437)			
Weekly pay (log)		0.238*** (0.0262)		
Senior managers weekly pay		-5.91e-05** (2.39e-05)		
% senior managers		-22.20*** (2.331)		
Ratio management expenditure			0.891*** (0.190)	
Electronic or automated invoices				-0.00377 (0.0483)
Maintenance of systems				-0.220 (0.177)
Office software				0.283** (0.135)
Internal dev and/or sup management systems				0.318*** (0.0320)
External dev and/or sup management systems				0.182*** (0.0370)
Constant	0.607*** (0.0284)	-0.766*** (0.156)	0.604*** (0.0276)	0.322** (0.149)
Observations	294	267	284	239
R-squared	0.169	0.540	0.077	0.497
Industry Fixed Effects	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, *

p<0.1

Table 4 shows correlates of management scores in the form of OLS regressions for 2016 data at the cell level from individual surveys only. In separate regressions, the share of managers with degrees (MES), the average gross pay across the firm (ASHE), management service purchases as a fraction of total service purchases (APS) and software embodying

management tools (E-commerce Survey) are all positively and significantly related to management scores. What is more, the explanatory power of these relatively parsimonious regressions (as captured by the R^2 value) is relatively high).

Table 5: OLS estimates of managerial capital investment channels, linked sample

VARIABLES	(1)	(2)	(3)	(4)
	MES APS Ecom ASHE	MES APS Ecom ASHE	MES APS Ecom ASHE	MES APS Ecom ASHE
% managers with degree	0.104*** (0.0291)	0.108** (0.0533)	0.0981** (0.0484)	0.0964** (0.0471)
% of managers		-0.168 (0.175)		
% non-managers with degree		0.00786 (0.0527)	0.00748 (0.0465)	0.0135 (0.0459)
Weekly pay (log)	0.0260 (0.0315)	0.0439 (0.0378)	0.0991*** (0.0340)	0.110*** (0.0368)
Senior managers weekly pay		-2.19e-06 (2.82e-05)	-2.98e-05 (2.58e-05)	-3.40e-05 (2.61e-05)
% senior managers			-14.77*** (2.164)	-16.44*** (2.135)
Ratio management expenditure	0.152 (0.152)	0.176 (0.151)	0.107 (0.141)	0.171 (0.144)
Development management systems	0.0979* (0.0519)	0.0871 (0.0544)	0.0536 (0.0488)	
Support management systems	0.254*** (0.0638)	0.258*** (0.0695)	0.162*** (0.0620)	
Electronic or automated invoices	-0.0151 (0.0597)	0.0197 (0.0696)	-0.0176 (0.0677)	-0.0148 (0.0704)
Maintenance of systems		-0.294** (0.142)	-0.326** (0.155)	-0.284* (0.159)
Office software		0.186* (0.0986)	0.218** (0.105)	0.255** (0.107)
Internal dev and/or sup management systems				0.136*** (0.0372)
External dev and/or sup management systems				0.0887*** (0.0335)
Constant	0.140 (0.167)	0.154 (0.216)	-0.00889 (0.205)	-0.0907 (0.206)
Observations	238	224	224	224
R-squared	0.586	0.604	0.658	0.646
Industry Fixed Effects	Yes	Yes	Yes	Yes

Robust standard errors in
parentheses

*** p<0.01, ** p<0.05, * p<0.1

However, once we combine information at the cell level from several business surveys, as we do in Table 5, signs flip, significance disappears, while the R^2 increases only moderately. In the fullest specification, only the average pay level, the share of managers with degrees, and the use of management-technology embodied in software are positively and significantly correlated with management score at the cell level. Interestingly, the proportion of senior managers in the business is significantly negatively correlated with the overall management score.

While not ready for inclusion in this draft, future iterations of this working paper will make use of the panel nature of the data that is gained by moving from the firm level to the cell level. It will also take the distinction between stock variables and flow variables more seriously.

A final note of caution is necessary regarding the components of the framework in Section 2 not currently included in these regressions. These are the learned components of managerial capital, whether within the industry (horizontal learning) or along the supply chain (vertical learning). To the extent that learning from competitors occurs within the narrowly defined industry-size cells we construct, our analysis will miss it completely. The relatively small amount of variation captured by our larger industry fixed effects suggest that this channel is unlikely to be operating to any substantial degree at the level of broad industry groupings. Finally, while vertical learning is completely outside of the scope of this analysis, perhaps new information from Extended Supply and Use Tables could be worth investigating in the future.

5.3. Clustering analysis

Finally, to examine the extent to which different types of managerial capital investment occur jointly in firms, we perform a very simple clustering analysis using a K-means algorithm. The algorithm minimises

$$\operatorname{argmin}_{\mathbf{S}} \sum_{i=1}^k \sum_{x \in \mathcal{S}_i} \|x - \mu_i\|^2$$

Where μ_i is an initial centroid and x is a vector composed of our proxies of managerial capital investment. The number of clusters is then chosen to minimise the residual sum of squares subject to a penalty for the number of clusters.

[CLUSTERING RESULTS TO FOLLOW]

6. Discussion and further research

In this paper, we have outlined a framework for thinking about managerial capital across all accumulation channels, whether they involve direct investment, are embedded in other assets of the firm, or involve learning from suppliers, customers, and competitors. We then used the novel ONS Management and Expectations Survey 2020 and existing UK microdata sources to paint a fuller empirical picture of the distribution of management practices and the channels of managerial capital accumulation at work in the UK economy. Depending on the specification, we have found that human capital, tangible and intangible capital and outright purchases of management services are all widespread ways to increase managerial capital and are often employed in complementary ways. This complementarity is a double-edged sort: it means that in individual surveys, each of these channels is usually a decent proxy of the total amount of managerial capital accumulation, but equally implies that we cannot analyse the individual contributions of a channel without also observing the others. These new empirical results can not only help us understand firms' input choices better but may in the future also allow us to improve our estimates of intangible capital, and therefore refine our understanding of TFP growth over time.

However, this paper only presents a first attempt at using the full range of UK business surveys to estimate managerial capital. Many caveats remain. First, the surveys employed here are not explicitly designed to measure managerial capital investment, and care needs to be taken when interpreting questions as such. While we have consulted with subject matter experts, uncertainty remains over some of the questions. Second, in order to link data across surveys and across waves in a balanced panel, we have conducted the empirical

analysis at detailed industry-size cell levels. However, in doing so we risk wrongly assuming that sampled firms are representative of their industry-size cell (something we partly explore in this paper) and moreover cannot explore within-cell variation between firms. Finally, we stress that in the empirical section of the paper, we only perform a decomposition of managerial capital into investments through different channels. Investment decisions are however endogenous choices of the firm, and we therefore cannot (and do not) make any causal claims in this paper.

We hope this paper spurs further research in at least three directions. First, similar exercises are possible with microdata in other countries (for instance, the MOPS in the United States, see Bloom et al. (2013)), enabling internationally comparable estimates of managerial capital and the channels through which it is accumulated. Second, as we have stressed, this paper provides a framework for thinking about managerial capital accumulation and a discussion of the available microdata that may be used to capture the different channels. Future work can hopefully go beyond this descriptive exercise to explain when, how and why firms shift between different modes of managerial capital investment, and how those choices complement the other strategic choices a business makes. Finally, we hope that by drawing attention to this important component of intangible capital, we can ultimately improve the way these important measures are captured in business surveys, in the United Kingdom and elsewhere.

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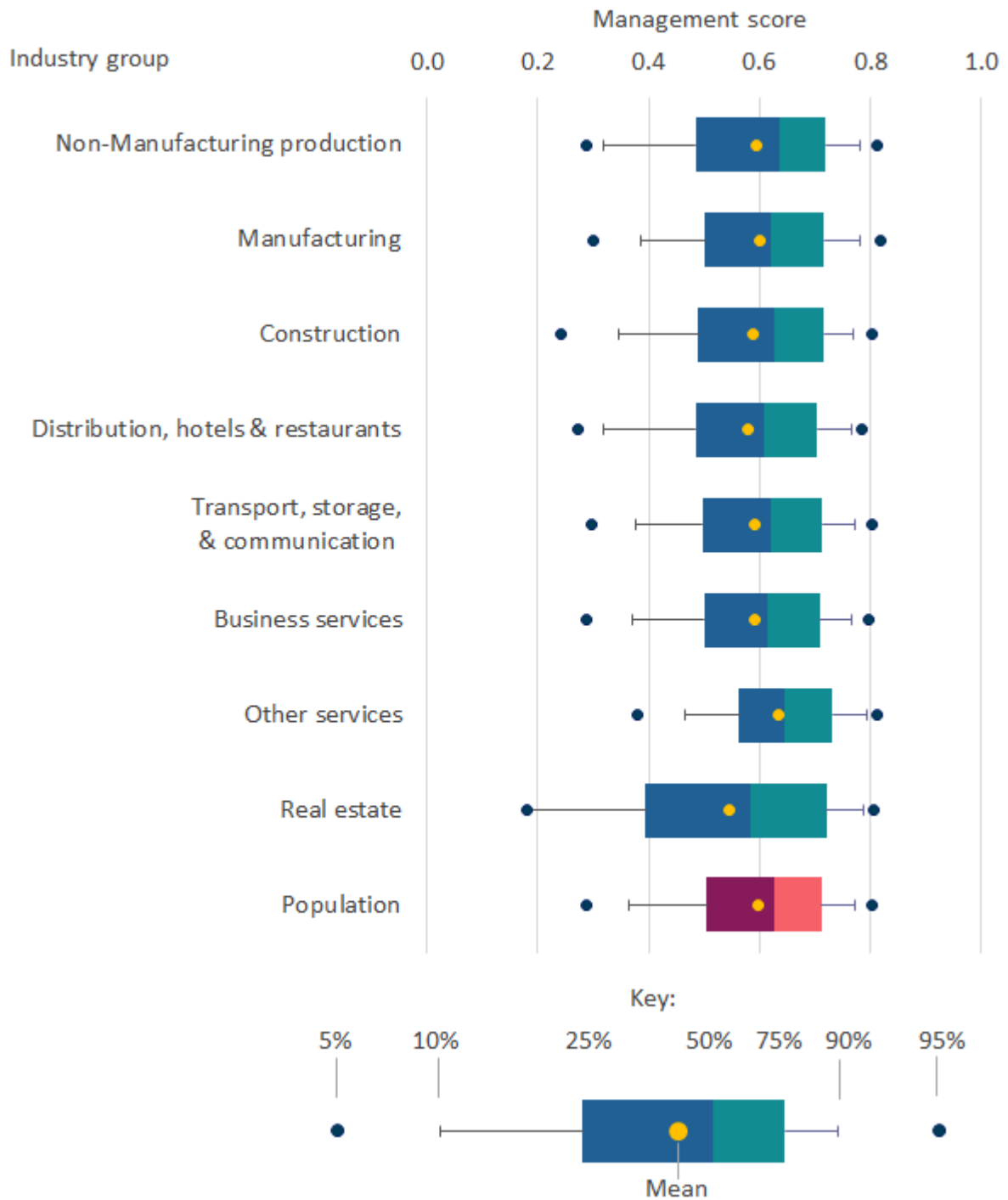
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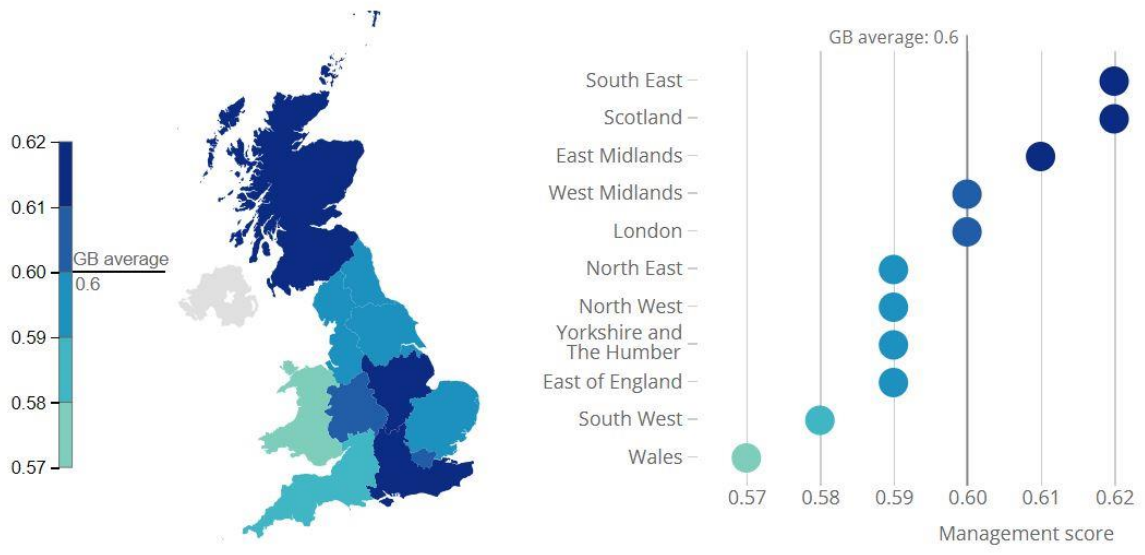
Appendix A1. Figures and Tables

Figure A1.1: Industry variation in management scores



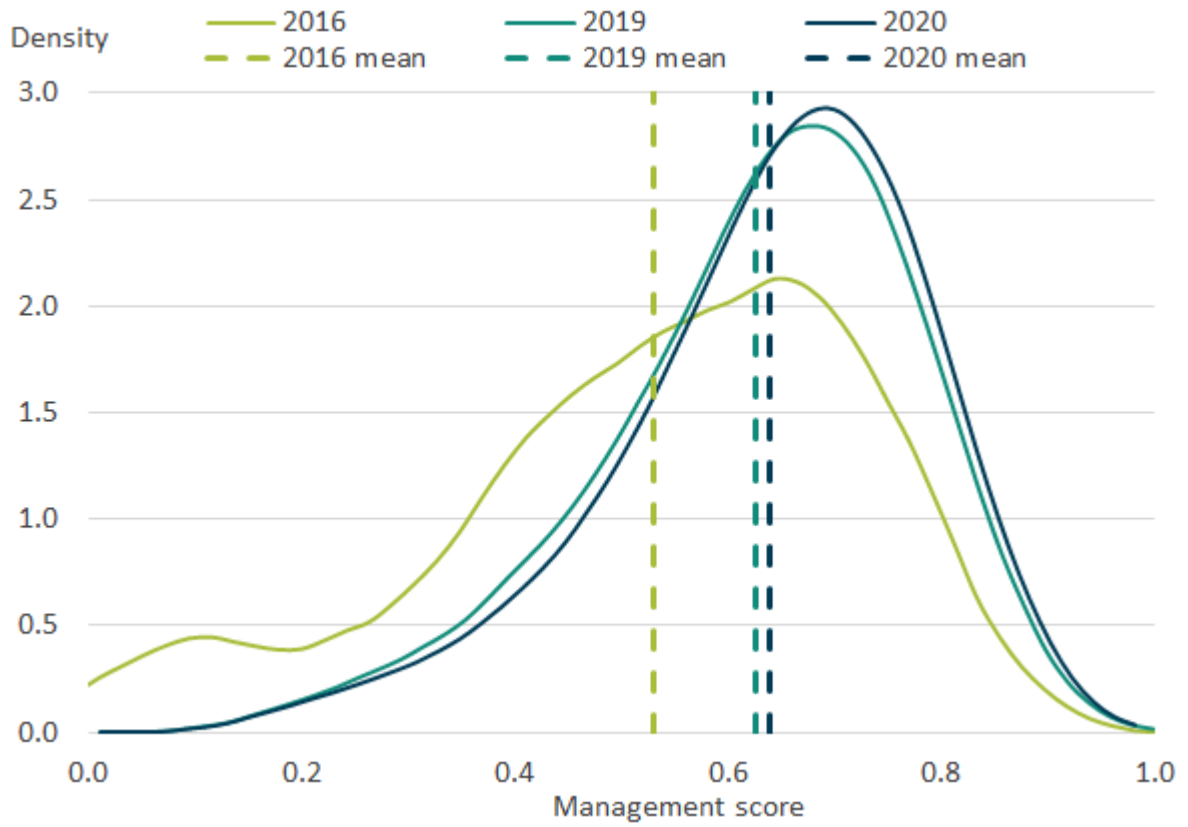
Source: ONS (2021a)

Figure A1.2: Industry variation in management scores



Source: ONS (2021a)

Figure A1.3: Management practices in Great Britain, 2016-2020 (linked sample)



Source: ONS (2021a)

Table A1.1: Predictors of MES 2020 survey response, for total sample and linked sample

VARIABLES	Response to MES (1)	Response to MES (2)	Response to MES (3)	Response to MES (4) (linked firms)	Response to MES (5) (linked firms)
Employment (scaled by 100)	-0.000540*** (0.000205)	-0.000487** (0.00195)	-0.000535*** (0.000194)		-0.000128** (0.0000609)
Turnover (scaled by 1000)	-0.00*** (0.00)	-0.0000107** (0.00)	-0.00** (0.00)		-0.00 (0.00)
Foreign Ownership			-0.0285*** (-0.00559)		
Score_2016				0.317*** (0.00549)	0.316*** (0.00550)
Observations	50,712	50,712	50,712	14,896	14,896
R-squared	0.001	0.006	0.007	0.17	0.17
Industry fixed effect	No	Yes	Yes	Yes	Yes
Region fixed effect	No	Yes	Yes	Yes	Yes

Table A1.2: Summary Statistics

[TABLE A1.2 HERE]

Table A1.3: Full OLS regressions, MES score (2016 levels)**MES**

VARIABLES	(1) MES	(2) MES	(3) MES	(4) MES	(5) MES	(6) MES
% managers with degree	0.146*** (0.0251)	0.160*** (0.0285)			0.0924** (0.0411)	0.0922** (0.0407)
% of managers		-0.202 (0.142)		-0.297* (0.152)		-0.296* (0.155)
% non-managers with degree			0.141*** (0.0261)	0.168*** (0.0313)	0.0702* (0.0417)	0.0972** (0.0437)
Constant	0.569*** (0.0196)	0.599*** (0.0282)	0.575*** (0.0187)	0.617*** (0.0286)	0.565*** (0.0191)	0.607*** (0.0284)
Observations	294	294	294	294	294	294
R-squared	0.141	0.150	0.133	0.150	0.152	0.169
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

*** p<0.01, ** p<0.05, *
p<0.1

ASHE

VARIABLES	(7) ASHE	(8) ASHE	(9) ASHE	(10) ASHE	(11) ASHE
Weekly pay (log)	0.206*** (0.0234)		0.231*** (0.0322)	0.182*** (0.0217)	0.238*** (0.0262)
Senior managers weekly pay		0.000107*** (2.59e-05)	-1.30e-05 (2.83e-05)		-5.91e-05** (2.39e-05)
% senior managers				-20.24*** (2.225)	-22.20*** (2.331)
Constant	-0.702*** (0.155)	0.527*** (0.0355)	-0.842*** (0.192)	-0.502*** (0.143)	-0.766*** (0.156)
Observations	283	267	267	283	267
R-squared	0.243	0.123	0.267	0.472	0.540
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes

MES & ASHE

VARIABLES	(12)	(13)	(14)	(15)	(16)	(17)
	MES ASHE	MES ASHE	MES ASHE	MES ASHE	MES ASHE	MES ASHE
% managers with degree	0.0810*** (0.0285)	0.110*** (0.0312)	0.0779 (0.0503)	0.127*** (0.0296)	0.0760 (0.0496)	0.0639 (0.0447)
% of managers		-0.489*** (0.149)	-0.524*** (0.160)		-0.601*** (0.176)	
% non-managers with degree			0.0461 (0.0521)		0.0424 (0.0538)	0.0146 (0.0440)
Weekly pay (log)	0.169*** (0.0258)	0.187*** (0.0251)	0.182*** (0.0251)		0.225*** (0.0337)	0.199*** (0.0285)
Senior managers weekly pay				7.76e-05*** (2.42e-05)	-2.95e-05 (2.58e-05)	-5.79e-05*** (2.22e-05)
% senior managers						-22.39*** (2.291)
Constant	-0.492*** (0.166)	-0.528*** (0.163)	-0.492*** (0.163)	0.527*** (0.0299)	-0.708*** (0.203)	-0.530*** (0.169)
Observations	283	283	283	267	267	267
R-squared	0.270	0.313	0.316	0.197	0.344	0.562
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

*** p<0.01, ** p<0.05, * p<0.1

APS and MES & APS

VARIABLES	(18)	(19)	(20)	(21)	(22)
	APS	MES APS	MES APS	MES APS	MES APS
% managers with degree		0.145*** (0.0262)	0.1000** (0.0503)	0.167*** (0.0304)	0.102** (0.0490)
% of managers				-0.299* (0.158)	-0.377** (0.170)
% non-managers with degree			0.0560 (0.0504)		0.0895* (0.0507)
Ratio management expenditure	0.891*** (0.190)	0.707*** (0.199)	0.690*** (0.201)	0.687*** (0.191)	0.653*** (0.192)
Constant	0.604*** (0.0276)	0.562*** (0.0259)	0.560*** (0.0256)	0.609*** (0.0353)	0.619*** (0.0353)
Observations	284	284	284	284	284
R-squared	0.077	0.182	0.188	0.198	0.212
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, p<0.1

E-Commerce survey

VARIABLES	(23) Ecom	(24) Ecom	(25) Ecom	(26) Ecom	(27) Ecom	(28) Ecom	(29) Ecom
Development management systems	0.346*** (0.0321)	0.0659 (0.0518)	0.0667 (0.0533)	0.0734 (0.0537)			
Support management systems		0.328*** (0.0591)	0.329*** (0.0591)	0.347*** (0.0622)			
Electronic or automated invoices			-0.00519 (0.0731)	0.0273 (0.0723)		0.00160 (0.0509)	-0.00377 (0.0483)
Maintenance of systems				-0.348** (0.174)			-0.220 (0.177)
Office software				0.202 (0.124)			0.283** (0.135)
Internal dev and/or sup management systems					0.337*** (0.0287)	0.336*** (0.0280)	0.318*** (0.0320)
External dev and/or sup management systems					0.202*** (0.0359)	0.202*** (0.0339)	0.182*** (0.0370)
Constant	0.342*** (0.0421)	0.300*** (0.0469)	0.303*** (0.0700)	0.392*** (0.138)	0.356*** (0.0439)	0.355*** (0.0619)	0.322** (0.149)
Observations	239	239	239	239	239	239	239
R-squared	0.451	0.505	0.505	0.519	0.484	0.484	0.497
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*** p<0.01, ** p<0.05, * p<0.1

MES & E-Commerce survey

VARIABLES	(30) MES Ecom	(31) MES Ecom	(32) MES Ecom	(33) MES Ecom	(34) MES Ecom	(35) MES Ecom	(36) MES Ecom
% managers with degree	0.133*** (0.0231)	0.118*** (0.0236)	0.123*** (0.0246)	0.121*** (0.0274)	0.129*** (0.0291)	0.127*** (0.0282)	0.132*** (0.0284)
% of managers				-0.0695 (0.135)	-0.0510 (0.141)	-0.0553 (0.137)	-0.0552 (0.135)
Development management systems	0.317*** (0.0297)	0.0985* (0.0539)	0.0930* (0.0533)	0.107* (0.0565)			
Support management systems		0.261*** (0.0628)	0.250*** (0.0638)	0.264*** (0.0679)			
Electronic or automated invoices			0.0454 (0.0645)				0.0520 (0.0441)
Maintenance of systems				-0.273* (0.143)		-0.185 (0.148)	-0.224 (0.152)
Office software				0.200* (0.105)		0.254** (0.109)	0.251** (0.106)
Internal dev and/or sup management systems					0.299*** (0.0295)	0.279*** (0.0306)	0.272*** (0.0317)
External dev and/or sup management systems					0.203*** (0.0329)	0.182*** (0.0327)	0.178*** (0.0331)
Constant	0.321*** (0.0359)	0.290*** (0.0402)	0.263*** (0.0618)	0.362*** (0.123)	0.341*** (0.0510)	0.300** (0.134)	0.298** (0.135)
Observations	239	239	239	239	239	239	239
R-squared	0.537	0.570	0.572	0.580	0.557	0.567	0.570
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

*** p<0.01, ** p<0.05, *p<0.1

MES and each survey separately

VARIABLES	(37) MES	(38) MES ASHE	(39) MES ASHE	(40) MES APS	(41) MES Ecom	(42) MES Ecom
% managers with degree	0.0922** (0.0407)	0.0760 (0.0496)	0.0639 (0.0447)	0.102** (0.0490)	0.121*** (0.0274)	0.132*** (0.0284)
% of managers	-0.296* (0.155)	-0.601*** (0.176)		-0.377** (0.170)	-0.0695 (0.135)	-0.0552 (0.135)
% non-managers with degree	0.0972** (0.0437)	0.0424 (0.0538)	0.0146 (0.0440)	0.0895* (0.0507)		
Weekly pay (log)		0.225*** (0.0337)	0.199*** (0.0285)			
Senior managers weekly pay		-2.95e-05 (2.58e-05)	-5.79e-05*** (2.22e-05)			
% senior managers			-22.39*** (2.291)			
Ratio management expenditure				0.653*** (0.192)		
Development management systems					0.107* (0.0565)	
Support management systems					0.264*** (0.0679)	
Electronic or automated invoices						0.0520 (0.0441)
Maintenance of systems					-0.273* (0.143)	-0.224 (0.152)
Office software					0.200* (0.105)	0.251** (0.106)
Internal dev and/or sup management systems						0.272*** (0.0317)
External dev and/or sup management systems						0.178*** (0.0331)
Constant	0.607*** (0.0284)	-0.708*** (0.203)	-0.530*** (0.169)	0.619*** (0.0353)	0.362*** (0.123)	0.298** (0.135)
Observations	294	267	267	284	239	239
R-squared	0.169	0.344	0.562	0.212	0.580	0.570
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in
parentheses

*** p<0.01, ** p<0.05, * p<0.1

MES, APS & E-Commerce

VARIABLES	(43)	(44)	(45)	(46)	(47)
	MES APS Ecom	MES APS Ecom	MES APS Ecom	MES APS Ecom	MES APS Ecom
% managers with degree	0.119*** (0.0251)	0.114*** (0.0246)	0.111*** (0.0241)	0.120*** (0.0242)	0.118*** (0.0238)
Ratio management expenditure	0.231 (0.159)	0.187 (0.154)	0.194 (0.148)	0.221 (0.149)	0.249* (0.148)
Development management systems	0.0873 (0.0531)	0.0949* (0.0538)	0.101* (0.0560)		
Support management systems	0.247*** (0.0636)	0.260*** (0.0624)	0.266*** (0.0656)		
Electronic or automated invoices	0.0548 (0.0634)				
Maintenance of systems			-0.276* (0.145)		-0.191 (0.148)
Office software			0.208** (0.102)		0.263** (0.103)
Internal dev and/or sup management systems				0.297*** (0.0271)	0.275*** (0.0287)
External dev and/or sup management systems				0.203*** (0.0315)	0.181*** (0.0319)
Constant	0.256*** (0.0613)	0.289*** (0.0399)	0.343*** (0.118)	0.328*** (0.0374)	0.284** (0.126)
Observations	239	239	239	239	239
R-squared	0.575	0.572	0.582	0.559	0.570
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes

Robust standard errors in
parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A1.4: OLS regressions, MES changes (2016-2020) on investment measures separately

VARIABLES	(1) MES	(2) ASHE	(3) APS	(4) Ecom
MES score 2016	-0.568*** (0.0392)			
% managers with degree	0.00521 (0.0267)			
% of managers	-0.232** (0.0920)			
% non-managers with degree	0.0481* (0.0275)			
Weekly pay (log)		-0.152*** (0.0245)		
Senior managers weekly pay		7.33e-05*** (2.23e-05)		
% senior managers		6.287*** (1.941)		
Ratio management expenditure			-0.490*** (0.153)	
Electronic or automated invoices				-0.00877 (0.0554)
Maintenance of systems				0.162 (0.161)
Office software				-0.166 (0.138)
Internal dev and/or sup management systems				-0.119*** (0.0306)
External dev and/or sup management systems				-0.0922*** (0.0318)
Constant	0.435*** (0.0363)	0.943*** (0.144)	0.0764*** (0.0184)	0.179 (0.116)
Observations	285	262	276	231
R-squared	0.579	0.221	0.083	0.249
Industry Fixed Effects	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A1.5: OLS regressions, MES changes (2016-2020) on investment measures jointly

	(16)	(17)	(18)	(19)
	MES	MES	MES	MES
	APS	APS	APS	APS
	Ecom	Ecom	Ecom	Ecom
VARIABLES	ASHE	ASHE	ASHE	ASHE
MES score 2016	-0.709*** (0.0577)	-0.731*** (0.0444)	-0.803*** (0.0451)	-0.769*** (0.0472)
% managers with degree	0.00814 (0.0143)	-0.00208 (0.0210)	0.000234 (0.0195)	-0.00903 (0.0207)
% of managers		-0.0429 (0.0918)		
% non-managers with degree		0.0197 (0.0230)	0.0236 (0.0198)	0.0282 (0.0209)
Weekly pay (log)	0.0106 (0.0172)	-0.0352* (0.0209)	-0.00228 (0.0213)	0.00667 (0.0218)
Senior managers weekly pay		4.37e-05*** (1.35e-05)	2.77e-05** (1.33e-05)	2.76e-05** (1.39e-05)
% senior managers			-7.364*** (1.421)	-8.374*** (1.585)
Ratio management expenditure	-0.0265 (0.101)	-0.0228 (0.102)	-0.0400 (0.103)	0.00460 (0.114)
Development management systems	0.104*** (0.0306)	0.0939*** (0.0284)	0.0842*** (0.0281)	
Support management systems	0.0439 (0.0424)	0.0739* (0.0383)	0.0414 (0.0367)	
Electronic or automated invoices	-0.0398 (0.0345)	-0.0240 (0.0343)	-0.0413 (0.0334)	-0.0331 (0.0363)
Maintenance of systems		-0.0830 (0.0921)	-0.119 (0.0852)	-0.0781 (0.0810)
Office software		0.00111 (0.0823)	0.0303 (0.0728)	0.0522 (0.0637)
Internal dev and/or sup management systems				0.0614*** (0.0228)
External dev and/or sup management systems				0.0234 (0.0227)
Constant	0.347*** (0.105)	0.672*** (0.111)	0.595*** (0.116)	0.513*** (0.117)
Observations	230	219	219	219
R-squared	0.693	0.736	0.763	0.746
Industry Fixed Effects	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A1.6: Robustness Checks

[DIFFERENT CELL DEFINITIONS HERE, DIFFERENT PAY DEFINITIONS HERE]

Appendix A2. Data Construction

A2.1. Construction of the industry-size cells

We considered different ways of splitting the data across detailed industry, size and location cells. After initial exploration of a few possible divisions, we discarded location since it constructing location-cells made high demands on the data but did not offer much variation in terms of management practices. This is in line with the results in ONS (2021a). Therefore, we constructed cells based on the industry and size of firms alone.

We explored three options:

- 1) Two-digit SIC code and four size-bands
- 2) Three-digit SIC code and three size-bands
- 3) Three-digit SIC code and four size-bands

The results presented in this draft used the first option.⁹

For each individual survey, we cleaned the data and created the variables of interest at the firm level¹⁰ first. We then averaged across respondents in each narrowly defined industry-size cell. Averages were computed both weighted (using survey-specific weights) and unweighted, with little difference in the results.

Finally, we merged across the UK business survey datasets at the defined industry-size cell level to obtain the full dataset.

A2.2. IDBR Balance tests for sampled firms

[ADD BALANCE TESTS HERE]

⁹ Future drafts of this working paper will include results with all three cell definitions.

¹⁰ Technically, this is the reporting unit (RU) level of the IDBR for all surveys except the Employer Skills Survey, which is sampled at the slightly higher enterprise level, and the Annual Survey of Hours and Earnings, which is sampled at the employee level.