Exploring the workplace location problem in the Annual Survey of Hours and Earnings

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Abstract

The Annual Survey of Hours and Earnings (ASHE) is an important source of longitudinal linked employer-employee payroll earnings data for Britain. It provides accurate information on employees' hours and earnings and information on the location of employees and their place of work. This paper examines the accuracy of the workplace location in the data following concerns that the pre-filling of that data item by ONS in paper questionnaires results in measurement error. By linking the employee's workplace in ASHE to the same organisations in the Business Structure Database (BSD), and by examining employee commuting distances, we confirm that there is systematic measurement error in the recording of the workplace location in the ASHE among organizations where the survey is administered via a paper questionnaire. The study suggests a number of alternative approaches to improve the quality of the data and reduce the potential for biased estimates. This is particularly important in the context of regional earnings differentials, with their attendant implications for the levelling-up policy agenda.

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1. Introduction

The Annual Survey of Hours and Earnings is the central data source used by government and academics to understand changes to labour markets, wage differentials and earnings growth. Given its longitudinal characteristics and its ability to be linked to other central government administrative data sources, its importance for use in evidence-based policy intensifies and cannot be overstated. Nevertheless, it is not without its challenges as there are still important aspects of the data that are yet to be quality assured, raising questions about inferences that can be drawn from them. For example, these include ASHE regularly falling considerably short of the full 1% sample (Ritchie et al., 2021 – forthcoming), there appears to be no clear and consistent approach to identifying what constitutes a main job for employees with multiple jobs; and the levels of attrition in the sample far exceed expected levels (Forth et al., 2021 - forthcoming). Here we investigate one other such aspect, namely the location of employees' workplace, which we suggest is subject to systematic measurement error.

The Office for National Statistics administers the Annual Survey of Hours and Earnings (ASHE) in April of each year. Its characteristics include:

1. ASHE data are collected on a 1% random sample of employees via their employer.
2. The 1% sample is based on the individuals National Insurance number (NINo) – this means that if an individual has a specific NINo they will be in the sample for their whole working life regardless of which employer they work for.
3. Collection involves employer data input under statute in response to the ONS survey.
4. The survey for all employees is generally sent centrally to the employers PAYE registered address and not the local unit that the employee works at.
5. The collection of the survey can be via paper questionnaire or electronically.

Its main aim is to collect information on employee hours and earnings. The survey microdata is the most widely used of the datasets that ONS collects from business – partly because it (and its predecessor, the New Earnings Survey) have been available to government and academic researchers since the early 1990s. It is an important dataset for UK Government departments and other bodies set up to inform policy. For example, the Low Pay Commission relies on the dataset for its annual assessment of the National Minimum Wage, whereas the Bank of England use it as part of the evidence provided to inform setting of interest rates.

One key advantage of ASHE over other data sets is that it contains information on both an employee's home and work address (i.e., postcode). These data are, arguably, under-exploited. Nevertheless, the location variables have been used to shed light on important aspects of labour supply and to develop labour market policy. For example, ONS (2019a) used the ASHE workplace location in its study into the gender differences in commute time and pay. They found men tend to have longer commutes, while commuting time has a greater impact on the decision to leave one's job for women. While in their 2021 study on employee earnings using ASHE, they reported that the percentage of employees furloughed with reduced pay was highest in the South West and Northern Ireland (ONS, 2021a). Britton et al. (2021) used ASHE in a study for the Institute of Fiscal Studies, which reported that graduates tend to move to places with high average earnings, such as London, while graduates who grew up in places with low average earnings are more likely to move away. While Sanchis_Guarner and Lyytikäinen (2012), used the ASHE location markers to inform their analysis of commuting and the effects of road improvements on individual labour market outcomes. They found a positive impact of improved accessibility to work location on weekly wages and total hours worked. Gibbons et al. (2012) on the other hand used ASHE when considering methods for decomposing variation in wages into individual and group specific components. They concluded that independent of the choice of decomposition, area effects contributed to just a very small percentage of the overall variation in wages in Britain. The diversity of examples demonstrate the variety of agendas for which the location variable in ASHE are used. Given the concern over its accuracy, this raises questions in relation to the inferences that can be made.

Recent methodological work raises concerns over how these location data are collected. In late 2019, during a discussion on potential issues in relation to the ASHE survey, the Northern Ireland Statistics and Research Agency (NISRA) suggested there was a possibility of errors in the collection of the locations of employees workplace (and home) location employment in ASHE. This was thought to be particularly problematic when an organisation was required to submit a paper copy of the ASHE questionnaire. This is because in the case of paper questionnaires the employee's work location variable is sent out by the ONS to the employers PAYE registered address, already pre-filled in. However, jut over 350 employers are allowed to make an electronic submission (where the work location is not pre-filled) via what is termed a 'special arrangement' with ONS. In terms of observations, this equates to 0.5% of business, but 14% of individual ASHE observations (employees). The exact eligibility criteria for qualifying for special arrangements is not published by ONS, but they state on their website that "ONS has a special arrangement with some very large employers" (ONS, 2021b). Our analysis (see appendix 1) confirms that size of company is highly correlated (at the 1% level) with special arrangements, as is the following characteristics:

- Enterprises with over 50 multi-sites
- Public sector
- All other regions compared with London (in particular the North East, North West, South West and East)
- Company structure – in particular public corporation, local authorities and non for profit compared with registered companies

The data enable us to identify paper and electronic submissions so it is possible to test differences between them in order to assess whether there is potential for systematic measurement error in ASHE. We examine the hypothesis that employees working for employers who make an ASHE paper submission are more likely to have their work location incorrectly recorded. This may occur when the respondent fails to correct the work location variable that has been pre-filled by the ONS.

In exploring the extent and nature of any systematic measurement error in the workplace location recorded in ASHE, we begin by comparing employee location data for the same organisations using the ASHE and the Business Structure Database (BSD). The BSD is a 'snapshot' in time of the Inter-Departmental Business Register (IDBR), which is a live register of firms registered for VAT and/or Pay As You Earn (PAYE) in the UK.

This reveals that among the employers successfully linked across ASHE and BSD, a greater proportion of employees are observed as working at a head office in ASHE (94%) compared with the BSD (90%). Furthermore, the results show that when multi-site organisations fill in the ASHE survey by hand, they record a much higher proportion of their employees as working at their head office when compared to multi-site organisations filling in the ASHE survey electronically (34% compared to 8%). These organisations also record their employees as living considerably further away from their workplace, when compared with organisations that fill in the form electronically (28 kilometres compared with 16 kilometres).

Taken together these findings suggest there is substantial systematic measurement error in the workplace location variable in ASHE when organisations use standard paper-based reporting arrangements.

This is important as it may lead to inaccurate inferences about the role of geographies in understanding earnings and hours in local labour markets. For example, systematic error in locating employers in London (where head offices are often located) may affect estimates of regional wage gaps. This is because the wages of employees working in regions may be incorrectly attributed to the head office, which often will be in London or the surrounding area. The effect of this would be that

employees (with relatively low wages) are incorrectly included in the calculation for the average wage rate in London, inadvertently bring down the average wage rate of the capital. Our analysis, indeed, shows that the effect of excluding observations from multi-site companies making paper submissions reduces the average gross earnings in all regions, but this reduction is considerably reduced in London than all other regions – see discussion section for fuller details.

The rest of this report proceeds as follows. Section 2 describes ASHE and outlines the reasons why there may be measurement error in the workplace location variable. Section 3 provides details on the construction of the dataset and analytical method. Section 4 includes the analysis, presenting descriptive statistics and regression analysis in order to test the hypothesis that employees working for employers who make an ASHE paper submission are more likely to have their work location incorrectly recorded. Section 5 concludes before presenting a worked example of the potential affect, before providing some alternative suggestions how to manage any systematic measurement bias.

2. The Potential for Measurement Error in Workplace Location in ASHE

In order to limit the administration burden on employers, ONS send out the ASHE questionnaire to employers with their employees' work addresses pre-filled. The address is usually the companies PAYE registered address. For multi-site companies, this therefore means that the potential for systematic measurement error in this location variable has been built in to the system – over half the observations in ASHE (54%) relate to individuals who work for multi-site businesses who make a paper submission. This equates to over 18,000 enterprises (29% of all enterprises).

In most cases, an employee's pre-filled work address will be their enterprise's head office. This is because individuals are matched to enterprises through Her Majesty's Revenue and Customs (HMRC) Pay As You Earn (PAYE) data. The address in this dataset is whatever is registered for a company's PAYE scheme. As a company generally has only one PAYE scheme, which is usually administered from their head office, if the employer fails to change the pre-filled workplace postcode on the ASHE questionnaire for each employee, then the employee will be assigned a postcode that actually relates to the PAYE-registered address, rather than the employee's actual workplace postcode.

Since 2005, ASHE respondents have been asked whether their employees' workplace postcodes are different from the pre-filled postcode and, if so, to fill in the correct postcode. The form includes a subsequent instruction: *'The postcode should be for the employee's usual local site or office'*. However, the text for this instruction is a subscript to the main question, is in smaller print and, unlike

the main question, is not in bold font. This changed in 2010 when part of the sentence - ***'usual local site or office'*** was put in bold font for the first time – see figure 1 below.

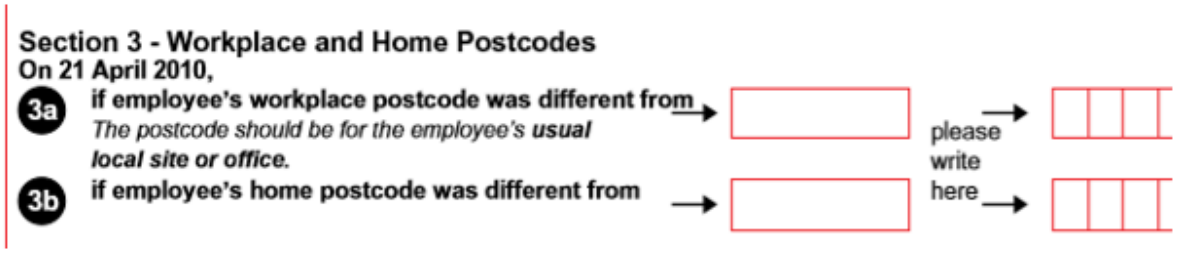

Figure 1: ASHE Questionnaire 2010

Source: ONS

Prior to 2005, although the questionnaire was broadly similar, the guidance was less clear, as employers were also referred to guidance notes on separate pages, and, if the respondent were to change the work address of their employee, they would be required to answer an additional 'Yes/No' question compared with the later surveys.

Given the marginal improvements in the questionnaire in 2005 and 2010, one may expect to see an increase in the number of employers changing the work address for their employees and hence improving the quality of the ASHE responses. Unfortunately, we are unable to test this assertion as ONS does not record when the workplace address has been changed.

However, regardless of the vintage of the questionnaire, given the lower prominence of the wording in relation to *'the employee's usual local site or office',* as well as the implied additional burden involved in finding and supplying the postcode for an employee's local office, it is unsurprising that some respondents may have missed it, or seen it, but preferred to take the least-cost option and not change it. Indeed, one could postulate that this potential for measurement error would increase as the number of enterprise employment sites and the size of the employer increases. This is because ASHE is a 1% sample of the working population and the more employees an organisation has, the more ASHE survey responses they are likely to have to submit. The ASHE questionnaires are also sent to a central office (PAYE registered office) and as such the administrative burden of identifying the correct site and altering the pre-filled questionnaire would increase as units and employment increased – particularly if (as is likely) the ASHE returns were all filled in by the same person/team within the organisation (presumably HR). However, given that a larger company may have more resources, such as automated systems for checking records, it is not inconceivable that the errors may be less prevalent for some of the very largest companies with more resources at their disposal.

This potential systematic measurement error in workplace location, however, could be partially offset by the *'special arrangements'* for collection of ASHE data, which ONS has with some of the largest employers. Instead of manually filling in a paper form for each employee in the ASHE sample, enterprises that qualify for special arrangements "provide electronic returns extracted from their employee records in April" (ONS, 2021b). In these cases, the accuracy of workplace data should improve for two reasons: first, the workplace postcode is not pre-filled and needs to be entered; second, enterprises could develop a programme to extract the data directly from their own electronic records. This approach should save a company time and reduce the risk of errors compared with filling in the paper forms individually for each employee.

3. Data construction and methodology

To assess the validity of the ASHE workplace variable, four data sources were linked which covered the years 2016 to 2018. The analysis was restricted to these three years as the 'special arrangements' marker used in the analysis was only available from 2016, while 2018 was the latest year data was available from the BSD. The four data sources were the ASHE annual datasets (Office for National Statistics, 2020), Eastings and Northings data (geographic point identifiers), and two versions of the Business Structure Database (BSD) – Enterprise dataset and Local Unit dataset (Office for National Statistics, 2019b). Initially the two BSD databases were linked; then ASHE and then the Eastings and Northings dataset were combined; finally, the two derived datasets were linked together.

The BSD contains a small number of variables (e.g., employment, turnover, industrial activity, postcode, census output area (COA)) for almost all business organisations in the UK. The BSD is derived primarily from the Inter-Departmental Business Register (IDBR). The main data sources are Value Added Tax (VAT) and PAYE records from HMRC. Additional information comes from Companies House, Dun and Bradstreet (private sector data supplier), and ONS business surveys. The IDBR covers around 2.7 million businesses in all sectors of the economy, but since the main two tax sources have thresholds (VAT is £85,000 and PAYE is £12,500 in 2021), businesses that are not registered for VAT and who do not operate a PAYE scheme will not be included on the register (ONS, 2006).

Much of the analysis in this study compares ASHE data with BSD data. Given much of the data used to compile the BSD comes from tax records, the assumption underpinning the analysis is that the data recorded in the BSD is most likely to be recorded more accurately, compared to survey data collected in ASHE.

The BSD is structured principally around four levels of UK businesses:

- enterprise group

- enterprise
- local unit
- reporting unit

An enterprise group is a group of legal units under common ownership (ONS, 2021c) – for example Whittard PLC.

This focus of this study is on the enterprise and local unit levels. The enterprise unit is defined as "the smallest combination of legal units (generally based on VAT and/or PAYE records) that is an organisational unit producing goods or services, which benefits from a certain degree of autonomy in decision-making, especially for the allocation of its current resources. An enterprise may be a sole legal unit (ONS, 2021c, p.2). The single or combination of legal units is classed as an enterprise and allocated an enterprise reference (ENTREF), which covers the group's operations. For example, this could be Whittard Supermarkets.

Geographically, the location of this legal entity (enterprise) will generally be the groups UK's head office, although this is not always the case.

However, research has suggested that it is at this national enterprise group level at which the organisation will most likely to be responsible for pay-setting responsibilities. Even where local management within large organisations appear to have autonomy, this is within a centralised corporate framework of budgetary control (Brown, Marginson, and Walsh, 2003).

A local unit is an enterprise or part thereof (e.g. a workshop, factory, warehouse, office, mine or depot) situated in a geographically identified place (ONS, 2021c). If there are multiple local units, each of these local units is allocated an individual identifier (LUREF) attached to a specific geographic locations. For example, each local Whittard shop would have its own LUREF. For single site business, conceptually, the ENTREF should be the same as the LUREF, however this may not always be the case. For example, an individual starting a business may register a company as a legal entity from their home address. By the time they start trading they may have then secured a business premises (e.g. a local shop) and both the company headquarters and the trading operation are run from the shop, even though the enterprise address will still be the home address.

Within the BSD dataset, LUREFs are consistent and can be linked over time. However, in the ASHE dataset, the LUREF variable is created each year, but only as a marker and therefore it is not able to be linked longitudinally nor directly with the BSD LUREFs. An advantage of undertaking analysis at the level of the enterprise is that potentially the ENTREF variable can be linked longitudinally. However, caution must be shown when linking this variable, as even when the underlying business

has not changed, the ENTREF can change overtime due to change of ownership, restructuring and renaming etc.

The reporting unit hold the mailing address to which the survey questionnaires are sent ONS, 2021c). As such, the ASHE survey will be sent to the reporting unit who can may respond for the enterprise as a whole, or parts of the enterprise identified by combining a number of local units. For example, an enterprise could have a number of reporting units that could be segmented in various ways such ass geographically or functionally – e.g. Whittard Retail (South West) or Whittard Financial Services.

To test whether there was any systematic measurement error in the reporting of the location of employment, we created geographical information markers for both the ENTREF (proxy for the headquarters) and the LUREF (workplace address) which was consistent between the ASHE and the BSD. This allowed us to assess the extent to which employment is centralised in the head office and to estimate commuting distances.

In order to achieve this, prior to merging the datasets, two technical challenges needed to be addressed. First, the LUREF identifiers in the ASHE and the BSD are different and do not allow direct matching. In the ASHE, the LUREF is only used to identify different sites within an enterprise group (e.g., labelled 1-10 for an organisation with 10 local units in that year). The identifier itself has no other characteristics and is not consistent between years. The LUREF in the BSD is meaningful and consistent across time. The solution was to create a 'proxy' LUREF consistently in both datasets, using geographic information (e.g., postcodes, COAs) for the local unit and enabling linking both at the ENTREF and proxy LUREF levels.

In order that a geographic reference is accurate and almost certain to relate to just one local unit, ideally the proxy marker would be created at the smallest geographic level possible (e.g., postcodes). Although full postcodes are available in ASHE, only partial postcodes (i.e., the first four digits) are available within the BSD dataset, posing the second technical challenge that we needed to address. Full postcodes were available in the BSD until 2018 (ONS, 2018), after which HMRC requested that they be suppressed – this meant that from 2018 onwards half of the postcode was removed from all data sets, including historic BSD back series. Therefore, as it was not now feasible to use postcodes to match the data sources, the next best alternative was to use Census Output Areas (COAs), the lowest level of geography that was available in both datasets. COAs are approximately ten times the size of postcode areas, which would typically cover just one or two streets. COAs cover between 40-250 resident households (postcodes have an average of 15 resident households) and 100-600 resident people. The recommended size of a COA is 125 households.

There are, however, advantages to COAs over postcodes. Postcodes can change if delivery routes change, while COAs have persistence for ten years or more. COAs may also be more meaningful for employment at large operations with different postcodes for separate functions of the same business effectively operating on a single site (e.g., large automotive factories making different vehicles at opposite ends of the same site or a university campus). As part of their work to analyse the Workplace Employment Relation Study (Kersley et al., 2005; Stokes at al. 2017; Van Wanrooy, 2013), the authors found that this was also a common phenomenon for hospitals, as they tend to have clusters of different buildings all centred around the same location, but often treated as different LUs on the IDBR.

The local unit variable and COA variable were combined to create a proxy LUREF (LU_COA). This solution does not provide a perfect match, as some organisations may have multiple LUs in the same COA and within the same industry (e.g., two or more Whittard Metros in the one COA). Due to the larger geographic coverage of COAs, this meant that there was an increased likelihood that the proxy local unit marker may contain more than just one local unit. Therefore, the resulting proxy LUREF marker may be conceptually best understood as a super local unit. However, in our analysis we assume that these are the same physical location, just split up for statistical purposes and will make little difference to the reported analysis on commuting distance.

Given the earlier assumption that the enterprise (ENTREF) is a good proxy for the head office, a marker was created in the BSD enterprise dataset and allocated to a specific geographical area using its COA – this resulted in the creation of a new 'head-office variable'. The BSD enterprise and local unit datasets were then merged.

This newly created single dataset contained the necessary information to undertake the analysis. It was merged to the ASHE dataset via consistent ENTREF and LUREF identifiers in both datasets. Following the merge, three potential outcomes were possible – these are illustrated in Figure 2.

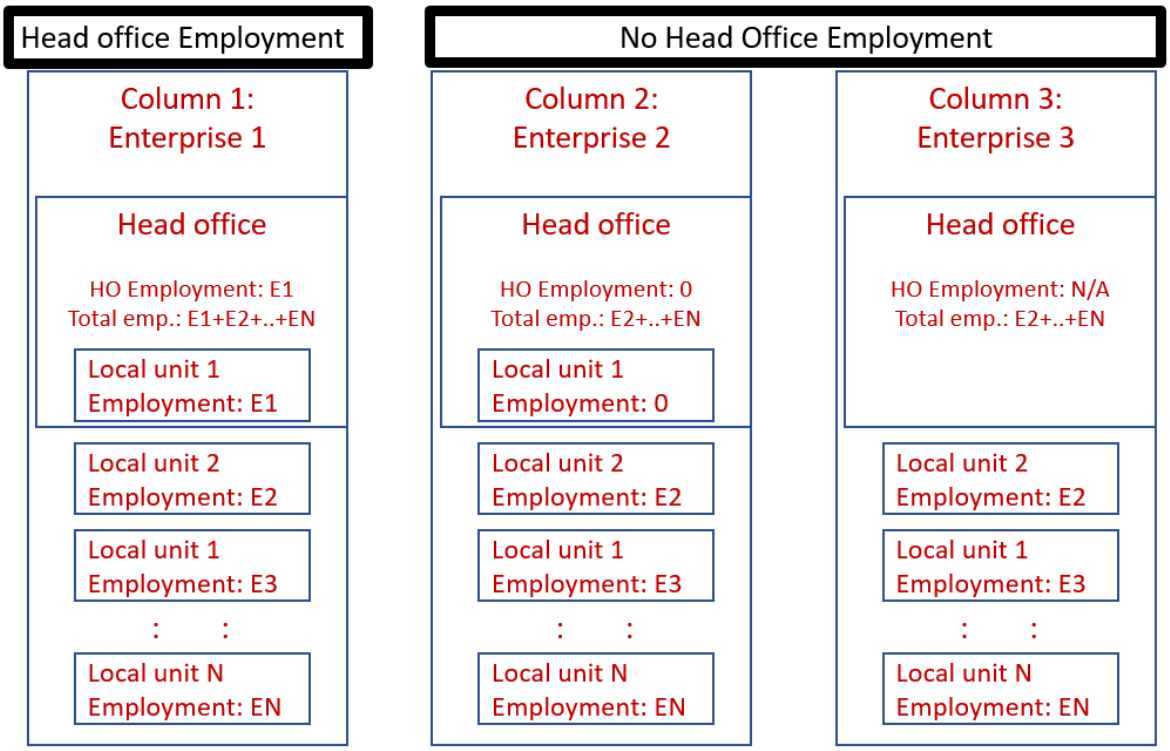

Figure 2: BSD and ASHE Merge - Head Office Employment

Column 1 shows that head office employment will be equal to Local Unit 1 employment – this is because the head office (ENTREF) and local unit 1 (LUREF) COAs match and there is employment recorded in the local unit. Columns 2 and Column 3, show the scenarios under which no head office employment will be recorded. Column 2 illustrates that the COAs of the head office (ENTREF) and local unit (LUREF) match, but there is no employment recorded in the local unit (e.g. shell company). While Column 3 describes the situation where there was no match between the location (COA) of the head office (ENTREF) and the location of their local units. In the matched dataset this equated to approximately 6,400 enterprises (10 % of ASHE sample) employing approximate 23,000 people (13% of employees). This could be for a number of reasons including coding error, delay in updating records, or potentially shell company structure. Given the complexities of the IDBR/BSD, it beyond the scope of this paper to identify the exact reason. However, given our methodology for identifying the head office (ENTREF), and that in this scenario no head office employment can be observed, these observations are excluded from the head office analysis.

Prior to linking with the BSD, the ASHE annual datasets were directly linked with Eastings and Northings (geographic point-based data) through the postcode variable. This allowed the calculation of the straight-line difference in metres between an employee's home address and their recorded workplace address on ASHE.

In this analysis, we assume that residential postcodes are correct as they are derived from PAYE tax records. However, we recognise that this a strong assumption, as there is also likely to be some measurement error for this variable. As this information already comes pre-filled from PAYE records, and as with the work postcode, employers are requested to change the address if incorrect. To do so, employers need to be aware that an employee had moved address and must be minded to make that change on the form. There is, however, even less incentive for employers to change an employee's pre-filled home address, since from at least 2012 instructions on the ASHE questionnaire state that responding to this question is voluntary. Overall, however, we expect the error to be considerably smaller than for workplace postcodes. This is because a residential address comes from tax records, and an employee is assumed to have lived there in the past year and still work for their present employer. Further, even if an employee moved, then it is likely that they moved locally. If this is the case, then it will make little difference to the analysis undertaken here on travel distance.

4. Analysis

The analysis reported here is for 2018 only. Regression results for 2016, 2017 and pooled data from 2016-2018 are reported in appendix 2, 3 and 4 respectively.

Description of the data

ASHE & BSD comparison – how many people work at a head office?

Prior to analysing the data by special arrangements, Table 1 shows some descriptive statistics detailing the number of enterprises and the number of employees in the BSD and ASHE dataset, depending on the size of business and whether they are a single, multi-site or an unmatched enterprise. A single site organisation is an enterprise that has one LUREF associated with it; a multi-site has more than one LUREF associated with it. The unmatched totals show that there were 1,472 individuals (1.5% of sample) working for 976 organisations (0.8% of sample) that had an ENTREF in ASHE that did not match to any of the ENTREFs in the BSD – the numbers and percentage of sample were broadly consistent across all three years. Given that the BSD is a (near) comprehensive list of UK organisations and is used as the main sampling frame for businesses surveys, we would expect a near 100% match rate. An unmatched response could either be the result of a processing error (i.e. an incorrect ENTREF recorded) or could be the result of a change in the enterprise reference (e.g., resulting from a takeover) between the March (ASHE) and May (BSD) sample dates, and a delay in updating records. The data for the unmatched records is therefore excluded from subsequent analysis; however, it has been included in table 1 in order that numbers can be reconciled between tables presented later.

Table 1: Numbers of enterprises in BSD and number of enterprises and employees in ASHE, by size of enterprise and whether single or multi-site (2018) [1]

	Enterprises by size (BSD)			Enterprises by size(ASHE)			Employees (ASHE)		
	Single site (1)	Multi-site (2)	Total (3)	Single site (4)	Multi-site (5)	Unmatched (6)	Single site (7)	Multi-site (8)	Unmatched (9)
micro 0-9	3,069,457	75,921	3,145,378	14,765	295	-	15,252	318	-
small 10-49	218,799	41,119	259,918	19,138	3,569	-	21,153	4,096	-
medium 50-249	27,125	22,024	49,149	8,728	7,936	-	13,245	12,812	-
large 250 - 999	2,262	6,197	8,459	1,256	4,473	-	4,292	17,862	-
xlarge 1000-10000	304	2,488	2,792	162	2,080	-	2,744	49,019	-
xxlarge 10,000+	-	267	-	-	228	-	194	37,726	-
unmatched	-	-	-	-	-	976	-	-	1,472

Source: ONS, BSD and ASHE

Table 1, column 3 records that there were nearly 3.5 million organisations registered in the UK on the BSD in 2018, with over 3 million of these being single site micro businesses (96% of all businesses). There were less than 150 thousand multi-site organisations in the UK in 2018 (column 2). In the ASHE sample, there were approximately 64 thousand enterprises, covering in excess of 180 thousand employees (total of columns 7,8 and 9).

In ASHE (columns 4 – 9), micro (i.e. less than 10 employees) and small (10-49) enterprises accounted for nearly 60% of businesses, but less than 23% of the employees in the sample. Medium

[1] - denotes that the statistics have been suppressed due to the cell count being less than 10 in order to control for potential disclosure.

(50-249) and large (250-999) enterprises accounted for 35% of businesses and 27% of employees, while extra-large (1,000-9,999) and extra-extra-large enterprises accounted for 4% of enterprises, but nearly 50% of employees.

Table 2 compares head office employment for the same enterprises using the data recorded in the BSD (columns 1 and 2) and comparing that with data in ASHE (columns 3 and 4). Columns 1 and 3 are the full BSD and ASHE sample respectively, whereas columns 2 and 4 restrict the sample. The restriction removes firms which, although they have a head office identified, there is no employment at this location recorded in ASHE (i.e. enterprise A appears in the BSD and in ASHE, the HO location is defined from the BSD, but none of the enterprises workplace COA in ASHE match the BSD HO location).

It is also worth noting that the total number of ASHE enterprise in table 2 column 3 (57,198) is less than the 63,606 recorded in Table 1. This is because the 6,408 enterprise which could not be allocated a head office and have been dropped from the sample (as explained above).

Conceptually, in Table 2 the number of organisations in the BSD and ASHE (columns 1 and 3 and columns 2 and 4) should be the same as they refer to the same organisations identified in both data sources. The number of organisations in the BSD, however, is slightly lower than that in the ASHE (e.g. 56,168 compared to 57,198). This is because although the same enterprises are matched in both data sources, employment data is missing from some BSD records, which is needed to calculate the proportion of employment. Therefore, in the analysis reported here, those organisations with missing employment data in the BSD dataset are dropped.

Table 2: Numbers of enterprises and proportions of their employees based in head offices, by single site and multi-site enterprises, ASHE vs BSD (2018)

		BSD (1)	BSD restricted sample (2)	ASHE (3)	ASHE restricted sample (4)
single	Number of obs.	40,090	32,778	40,142	32,816
	Mean	100%	100%	81%	99%
	Median	100%	100%	100%	100%
multi	Number of obs.	16,078	11,172	16,080	11,174
	Mean	54%	61%	56%	80%
	Median	55%	66%	67%	100%
unmatched	Number of obs.	-	-	976	-
	Mean				
	Median				

Source: ONS, BSD and ASHE

We would expect 100% of both the BSD and ASHE single site employees to work at their head office (i.e. as there is only one site, ergo it must also be the head office). This is as expected for the enterprises in the BSD. However, within the full ASHE dataset only 81% are recorded as working at the enterprise location – defined as the head office in this study. This means that in 19% of cases, the ASHE location is present, but it does not match the location on the BSD. This is odd, but our interpretation of this is that may reflect a complex company structure, potentially identifying a shell company. A shell company is one that can be incorporated potentially to provide an advantageous legal and/or financial structure in a country where it may only have a limited physical presence.

To correct for this, we exclude those observations where there is zero head office employment (i.e. potential shell company). This reduces the size of the ASHE sample by just over 7 thousand organisations but potentially provides a better comparison with the BSD.

After this adjustment, columns 2 and 4 (excluding potential shell companies) of Table 2 shows that 100% and 99% of employees in the same single site enterprises are recorded as working at their head office in both the BSD and ASHE samples. However, in terms of multi-site companies, columns 2 and 4, shows that the same companies in ASHE report a considerably larger proportion of employees recorded as working at their head office than is recorded in the BSD: 80% compared to 61%. This difference in the proportion of employees reported as working in the head office in multi-site organisations is a positive indication of potential systematic measurement error in ASHE.

It is worth noting, however, that the overall averages in Table 2 may be hiding heterogeneity across different types of employers - a composition effect. For example, the number of local units in the enterprise might be a key variant. As such, in Table 3, we present the number and proportion of employees based in a head office by the size of a company. If systematic measurement error was present, we would expect to see little differences in the smallest organisations, but we would expect the differences to increase as the size of the company increases. This is because ASHE is a 1% sample, and as the size of the company increases, so does the likelihood of having more ASHE returns to make.

Alternatively, however, we may expect to see a U-shape in terms of potential measurement error. Initially the quality of the return may decrease as the size of employer increases and they have more forms to fill in. However, over a certain size the quality of return may improve for two reasons. First, a company may be able to invest more specialist resources in to completing the ASHE return. Second, the largest firms are more likely to qualify for special arrangements. Both of these factors should improve the quality of the information in the ASHE returns and therefore limit any mismeasurement of the individuals work location.

Table 3 shows that, when excluding potential shell companies (columns 2 and 4), for the remaining matched organisations the percentage of employees working in the head office is greater in the ASHE than the BSD for all but the very smallest organisations (0-9 employees). This difference becomes considerable (8 percentage points) for medium sized organisations (50-249) and increases to 9 percentage points for the very largest organisations (10,000+). There is a slight drop off in the difference to 7 percentage points for extra large companies (1,000 -10,000). This would be consistent with the greater resources available in such companies to use on responding to the ASHE and the greater numbers of these organisations qualifying for special arrangements with ONS (approximately 350 enterprises).

Table 3: Numbers of enterprises and proportions of their employees based in head offices, split by size of enterprise, ASHE vs BSD (2018)

size (n. of employees		BSD (1)	BSD, restricted sample (2)	ASHE (3)	ASHE, restricted sample (4)
micro 0-9	Number of obs.	13,923	10,919	13,977	10,959
	Mean	99%	100%	78%	100%
	Median	100%	100%	100%	100%
Small 10-49	Number of obs.	20,402	16,286	20,402	16,286
	Mean	94%	96%	79%	99%
	Median	100%	100%	100%	100%
Medium 50-249	Number obs.	14,792	11,390	14,792	11,390
	Mean	81%	87%	73%	95%
	Median	100%	100%	100%	100%
Large 250 - 999	Number of obs.	4,976	3,703	4,976	3,703
	Mean	60%	67%	57%	76%
	Median	62%	75%	67%	100%
Xlarge 1000-1000	Number of obs.	1,883	1,497	1,883	1,497
	Mean	35%	39%	37%	46%
	Median	21%	28%	24%	38%
Xxlarge 10,000+	Number of obs.	192	155	192	155
	Mean	15%	17%	21%	26%

	Median	7%	8%	7%	12%
Unmatched	Number of obs.	-	-	976	-
	Mean	-	-	0%	-
	Median	-	-	0%	-

Source: ONS, BSD and ASHE

Overall, a greater proportion of employees are reported as working in the head office in the ASHE compared to the BSD. Given that the BSD data is generated from administrative tax data triangulated with additional data sources, if we consider this to be the 'true' value, then the results suggest substantial workplace location measurement error in the ASHE data, which is not only related to whether the company has multiple sites, but also to the size of the company.

ASHE Analysis – how far do employees travel to work?

The following analysis decomposes the ASHE data to demonstrate the possible structural effects arising from the potential systematic measurement error in the workplace location variable. We focus on the implied distance that employees travel between their recorded residential and workplace addresses. This distance is not a commute distance but is a proxy for it as it measured the straight line distance from their home to work address.

Table 4 reports the average proxy distances employees travel to work, for those working at single site and multi-site enterprises, with and without special arrangements when reporting ASHE (i.e. paper submission or electronic submission).

Table 4: Distance (in kilometres) between recorded employee work and home addresses in the ASHE (2018)

Organisation type	Observations (1)	Average (2)	10th percentile (3)	50th percentile (4)	90th percentile (5)
Single site paper	56,647	16.6	0.5	5.7	29.5
Multi-site, paper	96,633	28.2	1.1	7.7	54.4
Single site, electronic	233	8.5	0.5	4.9	19.5
Multi-site, electronic	25,200	16.4	0.9	5.5	30.9

Source: ONS, ASHE

The results are consistent with potential systematic measurement error in the workplace location variable. For example, employees working for single site organisations (making both paper and electronic submissions) and multi-site enterprises with special arrangements, on average travel

16 kilometres or less to work (column 2). Whereas employees who work for multi-site organisations who provide a paper ASHE submission (where systematic measurement error is likely) on average are reported as living 28.2 kilometres from their reported workplace. If this were correct, then employees in these types of organisations would travel on average an additional 24 kilometres per day to commute to and from work. For this observation to be 'true', there would have to be systematic differences between multi-site organisations with and without special arrangements.

As such, rather than evidence of measurement error, it could be that the increased travel distance is due to the characteristics of the organisations themselves, and the people that work for them. There may be systematic differences in the types of organisations and nature of employment location (e.g., urban, town, rural) between multi-site, paper submission enterprises and all other types of organisations. For example, most employees for Tesco Metro would be unlikely to need to travel a long way to work, given there is likely to bee one local to them. This is also more likely to be the case generally for special arrangement firms, given that size of employer and number of local units are highly correlated for qualifying for special arrangements. This is explored further later in the report.

It is also worth noting that employees working for single site organisations who have special arrangements (i.e. electric submission) are reported to travel considerably less distance (8.5 km) than any other category of employee. This can be conceptualised as single site companies qualifying for 'special arrangements' are likely to be the very largest employers. As such, they may be at the heart of the local community and potentially dominate local employment (e.g., a university).

The distributional results also add some additional context. The data reveal that there are differences between multi-site paper submission organisations and its closest comparator, multi-site electronic submission organisations, at all points along the distribution (i.e., the 10^{th}, 50^{th} and 90^{th} percentiles). Although constant, the relative difference in the distance between multi-site organisation with paper and electric submission increases as one travels further along the distribution – i.e. the average distance travelled between the two groups is only 1.3 times greater for firms in the 10^{th} percentile group, whereas it is 1.8 times in the 90^{th} percentile group. This means that although the increase in commuting differences is consistent along the whole distribution, for all multi-site organisations who make a paper submission, individuals at the top end of the distribution disproportionately influence the difference in averages.

In order to interrogate the distribution of commuting distances, Figures 3 and 4 plot the kernel density estimates of the logged distance travelled to work for the four main groups: single site and multi-site enterprises, with and without special arrangements.

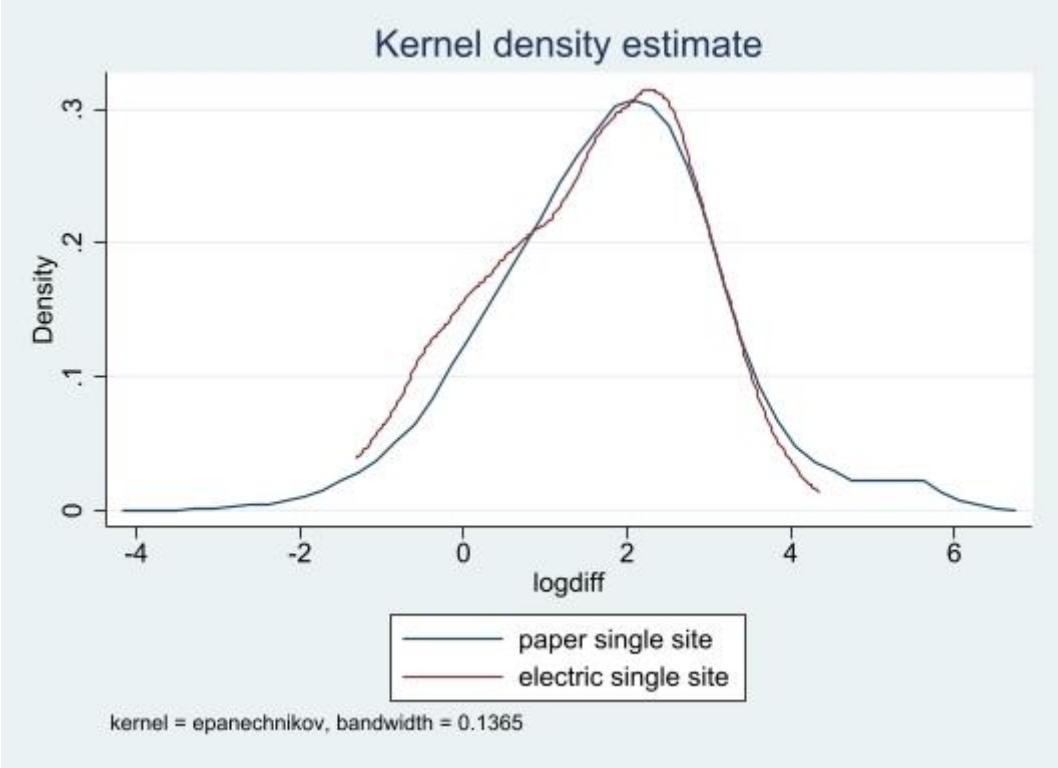

Figure 3: Kernel density plot of logged distance travelled to work of employees of single site enterprises, by paper and electronic submission (2018)

Source: ONS, ASHE

Figure 3 plots the distribution for single site enterprise only. It shows that the distribution for single site companies, whether making an electronic or paper submission broadly mirror each other, albeit single site companies making paper submissions have a longer tail. Potentially this may be the result of greater heterogeneity in the companies making paper submissions. For example, the left hand tail may represent small home businesses, whereas the right hand tail may represent shell companies, it may also reflect the considerably smaller number of observations in this category

Figure 4 plots the kernel density plot of distances travelled to work by employees working for multi-site companies making paper and electronic submissions.

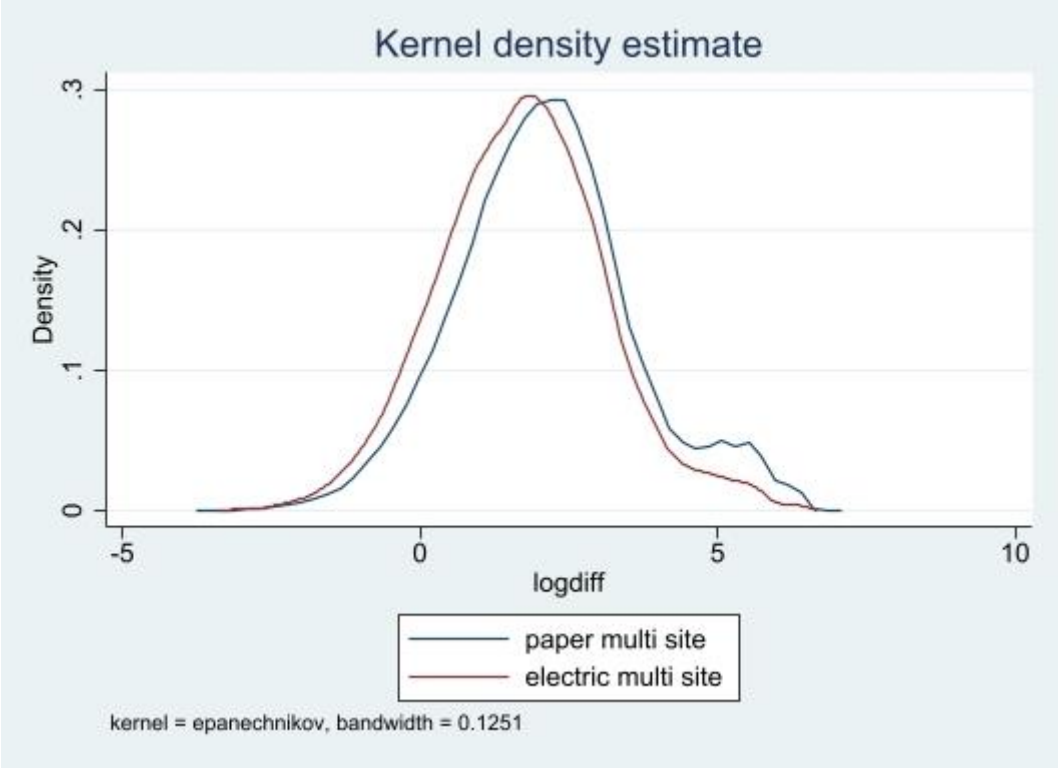

Figure 4: Kernel Density Plot of Distance Travelled to Work in Logs of Multi-site Companies, by Paper and Electronic Submission (2018)

Source: ONS, ASHE

Figure 4 clearly shows that there is a difference in the distributions between multi-site companies making paper submissions and multi-site making electronic submissions. Those making paper submissions report that their employees work further away from home than those making electronic submissions at all points of the distribution. Combine this result with the fact that distribution of multi-site companies making electronic submissions more closely aligns with the distributions of the single site organisations (e.g. the mean log difference is approximately equal to 2 in all three cases), this provides clear support for the hypothesis that employees working for employers who make an ASHE paper submission are more likely to have their work location incorrectly recorded.

In summary, the consistency of the difference in travel to work distances across the distribution between multi-site paper submission organisations and all other categories, including its conceptually closest comparator - multi-site electric submission organisations, suggest further support for hypothesis that there is potential systematic measurement error in the work location variable. However, given potential systematic differences in the types of organisations making paper

submissions, the following section explores to what extent size, number of local units and industry effects influences the reported distance travelled to work.

ASHE Analysis – to what extent do the characteristics of the firm impact on the reported distances travelled to work?

A priori, our expectation was that if there were evidence of systematic measurement error for multi-site companies making paper submissions, it would increase in relation to the total number of units and total number of employees of the enterprise. This is because the administrative burden of identifying the correct site and altering the pre-filled questionnaire would increase as units and employment increased. Related to this was the expectation that there would also be industry specific effects, particularly between public sector and private sector enterprises where the incentive to invest time to respond to national surveys may differ. For example, profit maximising firms may focus on the private cost to the firms, whereas those in the public sector may be more motivated by the social benefit of producing statistics as a public good, which are used in the allocation of public resources.

Table 5 explores the issue of size by reporting the reported distances travel to work for employees working both single site and multi-site companies, making paper and electronic submissions

Table 5: Number of observations in ASHE, and distance travelled to work, by size, single or multi-site and electronic or paper survey submissions

Number of employees		single paper	multi paper	unknown paper	single electric	multi electric
micro 0-9	Number	15,250	318	-	-	-
	Mean	12.0	12.0	-	-	-
	P10	0.0	0.5	-	-	-
	median	3.7	5.4	-	-	-
	P90	21.8	24.7	-	-	-
small 10-49	Number	21,137	4,096	-	16	-
	Mean	13.9	13.5	-	10.2	-
	P10	0.7	0.7	-	0.0	-
	median	5.7	5.9	-	1.1	-
	P90	26.4	26.0	-	30.3	-
medium 50-249	Number	13,116	12,745	-	129	67
	Mean	17.5	19.8	-	5.4	6.0
	P10	1.0	1.1	-	0.4	0.7
	median	6.5	7.3	-	3.4	4.1
	P90	31.0	36.8	-	14.0	12.3
large 250 - 999	Number	4,279	17,585	-	13	277
	Mean	28.3	24.9	-	10.2	10.0
	P10	1.3	1.1	-	2.2	0.6
	median	9.2	7.9	-	6.7	4.0
	P90	54.3	47.1	-	19.3	20.7
xlarge 1000-10000	Number	2,671	44,603	-	73	4,416
	Mean	41.1	31.2	-	13.5	20.0
	P10	1.3	1.2	-	2.5	0.8
	median	8.8	8.2	-	9.4	6.9
	P90	128.7	64.9	-	27.3	39.0
xxlarge 10,000+	Number	194	17,286	-	-	20,440
	Mean	18.7	33.9	-	-	15.7
	P10	1.0	1.1	-	-	0.9
	median	5.1	7.6	-	-	5.3
	P90	38.1	85.2	-	-	29.5
unmatched/ unknown	Number	-	-	1,465	-	-
	Mean	-	-	18.1	-	-
	P10	-	-	0.0	-	-
	median	-	-	4.6	-	-
	P90	-	-	33.4	-	-

Source: ONS, ASHE

Table five reveals that generally, for all category of enterprise (single/multi, paper/electronic), as the number of employees increases, so does the average travel to work distance. The exceptions to this are single site paper submission and multi-site electronic submission organisations for employers with greater than 10,000 employees and single site, electronic submissions with 50-249 employees.

Travel to work differences are generally lower for multi-site companies with special arrangements, than those with single sites. However, it is worth noting that for 50-249 and 250-999 employees there are relatively small number of observations (i.e., 67 and 277 respectively). We might expect employees of multi-site organisations to have similar or even lower commuting distances than employees working for single site organisations, especially those single site employees working for less traditional industries with local employment. This is because employees of multi-site employers who are motivated by limiting their commute time are more likely to target working for the local branch/site. Single site employees have no choice but to travel to the head office, regardless of their home location.

The data also reveal that the average distance travelled to work is longer for multi-site companies making paper submissions compared with multi-site companies making electronic submissions. This is true for all enterprise size categories, and generally increases as the number of employees increases (excluding extra-large companies). Calculating the difference in mean travel distances reveals multi-site paper companies travel on average an additional 14 kilometres for medium companies, to 18 kilometres for the very largest companies with over 10,000 employees. In relative terms, however, the differences reduce from over three times the distances for medium companies to over double the distance of x-large companies. Caution should be taken when directly interpreting some of these numbers due to the relatively low number of multi-site electronic organisations in certain size categories.

However, employees from the very largest multi-site organisations making paper submissions appear to travel over double the distance to work (33.9 km) than multi-site organisation making electronic submissions (i.e. 15.7 KM) and these observations are based on relatively large number of observations (approximately 20,000 each). In itself, this observation would seem to provide support for the hypothesis that there is systematic measurement error in the reporting of working location for multi-site organisations making paper submissions.

To counter the argument that the result presented here provide evidence of systematic measurement error, and in support of the argument that companies making paper submissions may

be structurally different, potentially a better comparison would be between single- and multi-site companies making paper submissions. The evidence here does suggest that there may be something structural about organisations who make paper submissions. Comparing the responses from these groups shows that there is relatively little difference in the responses of business employing up to 1,000 employees.

To support our hypothesis of systematic measurement error for multi-site companies making paper submissions, and that this was likely to increase as the size of the employer increased, we would have expected to see the longest travel to distances in these categories. This was not the case as for single site organisations employing between 1,000-10,000 employees, they appear to travel nearly 10km further to work. This observation, however, appears to be an anomaly; it is highly influenced by the 90th percentile, is considerably larger than for any other category and therefore potentially raises concern about the quality of the data. Given this, if this observation were excluded from the analysis, in line with the original hypothesis, extra-large and extra, extra-large multi-site organisations making paper submissions would have recorded the two longest distances to travel to work.

In the above analysis multi-site is just a binary variable; it gives no insight into the potential difference the number of units could have on the recorded distance travelled to work. A priori, if organisations were reporting the correct work address, then we would expect the average difference to reduce as the number of local units increases. This is because we would expect the employees to want to minimise their commute and choose to work at the nearest location. If our hypothesis were correct, however, we would expect to see an increase in the average distance travelled to work for multi-site companies making paper submissions as the number of local units' increases. This is because the task of allocating individuals to the correct work location becomes more complex as the number of local units increase. Therefore, this means there is a greater incentive for the organisation completing the form to leave the work location unchanged.

Given that larger employers are likely to have larger numbers of employees in the ASHE sample, we would also expect to see some evidence of size of the company interacting with local units. In order to explore this issue, Table 6 lists the distance to work by size of company and number of local units. The size of the organisations has been limited to companies employing 250 and above, in an attempt to ensure that sufficient numbers of observations can be generated for each cell to make any analysis purposeful and limit any issues in relation to disclosure.

Table 6: Distance to work by size of organisation and number of local units for those making paper and electric submissions

		Number of local units				
Paper submission		2-5	6-10	11-50	51-99	100+
large 250 - 999	Number of employees	7,410	4,019	5,292	623	241
	Number of organisations	2023	980	1212	141	47
	Average distance to work	24.5	24.4	25.1	23.7	42.9
	Median distance to work	8.3	8.1	7.2	6.6	9.3
xlarge 1000-10000	Number of employees	5,938	4,146	13,198	7,151	14,170
	Number of organisations	318	233	708	295	436
	Average distance to work	26.9	44.1	33.2	29.0	28.5
	Median distance to work	8.3	9.4	9.2	8.4	6.9
xxlarge 10,000+	Number of employees	-	-	3,192	979	12,074
	Number of organisations	-	-	30	12	99
	Average distance to work	-	-	39.8	32.4	33.9
	Median distance to work	-	-	10.5	9.3	6.6
Special Arrangements: Electronic submission						
large 250 - 999	Number of employees	119	107	47	-	-
	Number of organisations	36	22	11	-	-
	Average distance to work	12.6	6.2	12.6	-	-
	Median distance to work	4.1	3.1	5.8	-	-
xlarge 1000-10000	Number of employees	-	-	927	1,011	2,155
	Number of organisations	-	-	30	17	34
	Average distance to work	-	-	24.0	23.8	14.7
	Median distance to work	-	-	8.4	9.2	5.6
xxlarge 10,000+	Number of employees	-	-	-	-	17,571
	Number of organisations	-	-	-	-	62
	Average distance to work	-	-	-	-	13.9
	Median distance to work	-	-	-	-	4.8

Source: ONS, ASHE

Table 6 only includes observations where each cell counts includes both a minimum of 10 employees employed by aa minimum of 10 enterprises. Where either the number of observations for individuals or organisation has not been met, the data has been suppressed for disclosure purposes. Given the disclosure threshold, this does mean that for some cells the observation is based on relatively low number of observations – i.e. number of employees. Therefore, given this low level of disaggregation caution should be shown not to over interpret the data.

While acknowledging this caveat, it is worth noting that for large firms (250-999 employees) making paper submissions there is a substantial increase in the average distance that employees are reported to travel to work for those with over 100 local units (47 kilometres). This is the furthest average distance travelled by any single group, regardless of enterprise type, and is approximately 80% further than employees from the same type of enterprise (large/paper submission) but with less than 100 local units. This provides some support for the a priori expectation that suggests that for companies making paper submissions the distance will increase as number of local units increase; albeit the evidence is somewhat limited, as the distances travelled to work tend to fluctuate as the number of local units increases for other size categories making paper submissions.

For example, when comparing the results for xlarge and xxlarge organisations making paper submissions there is limited evidence that the distance increases as the number of units increases, and in most cases, the opposite is true. All travel to work distances; however, are substantial, generally around and above the 30km mark. This is nearly twice the average of single site paper organisation (16.6km), reported in table 4[2]. Given that if the travel distance were its true value, then we would expect the opposite - organisations with multiple sites to have lesser commutes – then this provides strong evidence of the potential for measurement error.

This finding is further supported as the distances recorded by multi-site organisations making electric submissions are considerably lower than that for their counterpart organisations making paper submissions and below the average for the single site organisation making a paper submission for the corresponding size band (see table 4) . However, it is worth highlighting that some of these averages are based on relatively low number of individual observations based in a small number of organisations (e.g. 47 employees from 11 enterprises, for large firm with 11-50 local units).

The evidence form the descriptive statistics suggest that there is systematic measurement error in the work location variable. This is because the results report that multi-site organisations making paper submissions report consistently further travel to work distances than both single site

[2] Single site paper organisation has been chosen as a comparator group as by its nature, must be an accurate measure of travel to work distance.

organisations and multi-site organisations making electronic submissions. The evidence shows that the travel distance is largest for large companies with over 100 local units. The difference with single site organisations is particularly telling in this context as the longer commutes for multi-site paper submission organisations is a contradiction to what would be expected if the employment location was a true value.

To explore whether there are any structural differences, Table 7 records the average distances employees live from their work location, broken down by sector and size of organisation. To generate sufficient observations to make the analysis meaningful, the sample has again been limited to organisations employing over 250 employees. Given the high level of disaggregation, a number of observations, particularly for electronic submissions, have been suppressed, as they did not meet the disclosure criteria for each cell containing a minimum of 10 individuals from at least 10 enterprises.

Table 7: Distance to work by size or organisation and sector for those making paper and electronic submissions

		Sector: 2-digit sic										
	Number of observations and distance to work	primary	manuf	utilities	constr.	sales	serv.	fin/ law	public	health	creative	other
Paper submission												
large	Employees	82	2,498	189	552	2,309	2,220	3,612	3,459	1,749	643	272
250 - 999	Enterprises	30	615	50	151	591	584	885	811	454	166	66
	Mean	50.7	21.8	18.6	51.8	25.4	31.2	33.8	13.5	19.2	15.6	28.3
	Median	12.5	7.6	10.0	18.7	7.7	7.4	10.8	6.0	6.2	5.5	9.6
xlarge	Employees	182	3,306	852	1,100	5,589	5,129	6,499	10,224	10,262	1028.0	432
1000-10000	Enterprises	16	184	26	60	260	269	382	386	329	57.0	21
	Mean	66.9	41.0	39.1	61.6	28.8	41.5	49.3	16.1	24.4	21.4	36.3
	Median	12.9	9.3	13.5	24.1	6.7	9.2	11.9	6.4	7.7	5.3	6.9
xxlarge	Employees	-	-	-	-	3,324	2,446	2,246	4,359	3,490	-	-
10,000+	Enterprises	-	-	-	-	24	17	26	38	32	-	-
	Mean	-	-	-	-	37.8	25.1	93.6	15.6	17.1	-	-
	Median	-	-	-	-	4.8	5.0	32.8	7.2	7.3	-	-
unmatched	Employees	-	78	-	47	107	160	240	136	92	-	507
	Enterprises	-	27	-	24	43	79	158	68	62	-	495
	Mean	-	25.0	-	49.6	24.3	33.3	29.3	10.7	7.8	-	8.1
	Median	-	8.2	-	10.2	5.5	5.5	6.4	4.2	3.4	-	3.8
Electric submission												
large	Employees	-	-	-	-	-	126	-	91	-	-	-
250 - 999	Enterprises	-	-	-	-	-	31	-	25	-	-	-
	Mean	-	-	-	-	-	5.3	-	10.6	-	-	-
	Median	-	-	-	-	-	2.7	-	6.2	-	-	-
xlarge	Employees	-	-	-	-	-	382	-	2,178	686	-	-
1000-10000	Enterprises	-	-	-	-	-	12	-	34	16	-	-
	Mean	-	-	-	-	-	14.1	-	14.1	16.6	-	-
	Median	-	-	-	-	-	6.9	-	6.3	7.9	-	-
xxlarge	Employees	-	-	-	-	7,361	3,420	2,177	5,075	-	-	-
10,000+	Enterprises	-	-	-	-	13	12	11	28	-	-	-
	Mean	-	-	-	-	11.8	13.1	22.9	16.4	-	-	-
	Median	-	-	-	-	3.4	4.4	9.2	7.4	-	-	-

Source: ONS, ASHE

Given the relatively low levels of observations for both individuals and organisations, the analysis presented is limited to high-level observations. In terms of paper submissions, there is considerable variation across the sectors. Within the private sector, the creative industries sector seems consistently low; this may be due to the characteristic of the firms (e.g., small, local, networked) and employees (e.g. freelancers working from home; urban dwellers). Individuals working in the construction and primary industries on the other hand may live further away from their registered

work location. Potentially this could also be due to the structure of the industry. Construction workers may be theoretically attached to an office location (some way away) but predominantly are mobile and work on site, therefore making their registered work address almost redundant. Those who work in the primary industries (e.g., extraction of raw materials, agriculture) may well be specialist and linked to a specific site, regardless of where they live.

In comparison, one would expect the two mainly public sectors (i.e., public and health) to provide the highest quality data, given the incentive to provide data to help plan public services. This is further supported by Ritchie (2021) whose analysis of survey responses for the BSD reported public sector firms as much more likely to return forms. The results from the public and health sector do indeed stand out and report considerably less distances to travel to work. Both are broadly in line with the benchmark (16km) of a single site enterprise making a paper submission.

Although there are only limited comparisons between paper and electronic submissions between sectors (due to many observations being suppressed to protect against disclosure), public and health are once again noticeable in their difference with other sectors. For all other sectors, in each comparable size category, the average travel to work distance is considerably greater for those making a paper submission, as opposed to an electronic submission. For example, for all private sector industries where comparisons are possible (sales, service and finance/law) within each size category, those making paper submissions are reported as travelling between twice and six times the distance to get to work. However, there is relatively little difference between paper and electronic submission for both the public and health sector, and at times the reverse is true – those making electronic submissions travel further. This would suggest that these sectors are indeed better at providing accurate information regardless of whether they are using paper or electronic submissions. This suggest that there may be greater value for ONS to focus on increasing electronic submissions from the private sector.

In summary, the descriptive statistics consistently provide evidence that there is potential for systematic measurement error in the work location variable in ASHE. This potential mismeasurement is most apparent for multi-site organisations in the private sector. The measurement error is potentially greater the bigger the organisation and the greater number of local units that organisation has. To investigate the association further, the following section uses multivariate regression in order to isolate the relationship by controlling for all other factors.

4.2 Regression analysis

To further explore which factors are independently associated with the proportion of head office employment and distance travelled to work for multi-site enterprises, a number of regressions were

run on the ASHE 2018 dataset, both at the level of the enterprise (Tables 8 and 9) and the level of the employee Table 10). The results were checked by running similar regressions for 2016 and 2017 years, as well as a pooled regression for years 2016-2018. The results for all years are similar and are reported in Appendix 1.

Enterprise level regressions – proportions at the head office

Table 8 and Table 9 report the regression results based at the level of the enterprise for multi-site companies only. The dependent variable in Table 8 is the proportion of head office employment in ASHE. Figures 5 shows the distribution of the dependent variables.

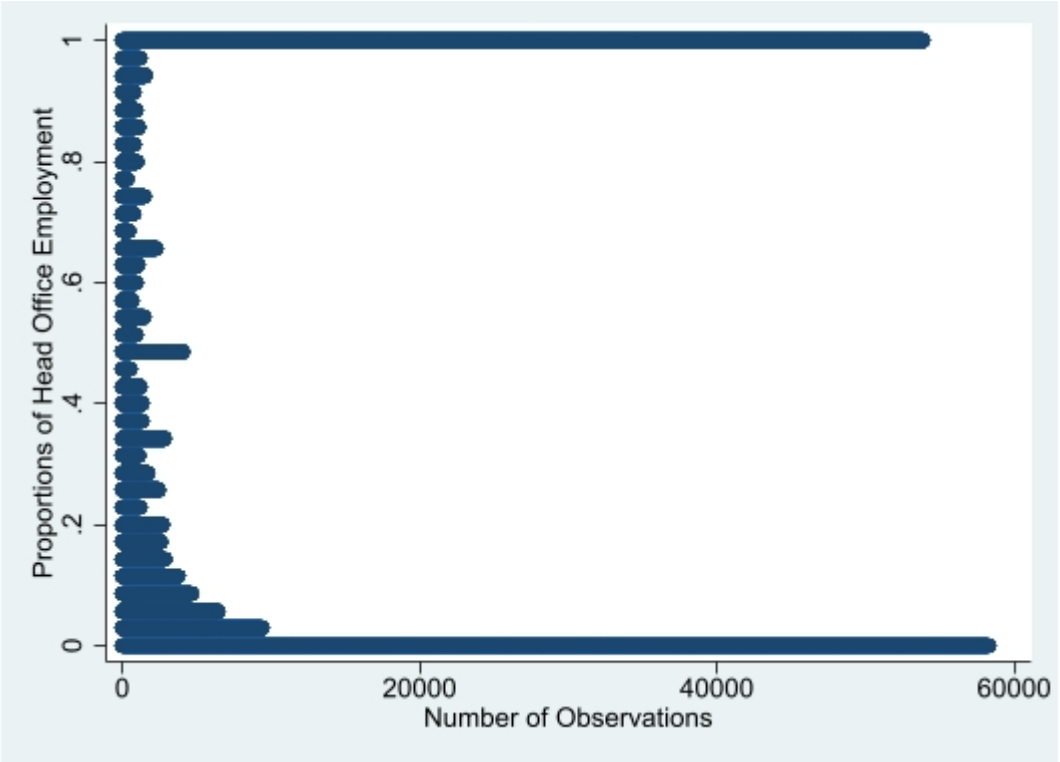

Figure 5: Number of individuals working for enterprises by the proportion of head office employment

Source: ONS, ASHE

Figure 5 shows that approximately 30% of employees (53,468) are employed by enterprises where there is no head office employment, 30% are listed as being employed by enterprises where everyone works at the head office (53,692) and the remaining 40% are spread across the distribution. This distribution shows that employees are more likely to work for an enterprise with lower proportions of head office employment.

In terms of the regressions, where there were multiple categories for each of the covariates, the largest group was always omitted. The control variables and omitted category for proportion of head office employment (and all following regressions) includ:

- Special arrangements - i.e., an electronic submission
- Sector - 2-digit (sector_2 omitted – public sector)
- Rural/urban classification (Iwur_class_8 omitted - urban city and town)
- Size of business - number of employees (continuous)
- Number of local units (llu_grp_1 omitted – 0-5)
- Region (lregion_8 omitted – London)
- Registered status (Idbrsta_1 omitted – registered as a company)

The full results category for proportion of head office employment are reported in table 8. Columns 1 and 2 are both OLS linear regressions. Column 1 reports the results of the regression for all multisite companies. Column 2 reports the results of a restricted model that excludes potential shell companies. While column 3 also restricts the sample to exclude potential shell companies, but is estimated using a Tobit (censored) model to account for the considerable number of employees working for enterprises with either zero or 100 percent of employees recorded as working at the head office.

Table 8: Regressions on the proportion at head office, all multisite enterprises and multisite enterprises ignoring 'shell' companies (2018)

Dependent variable: proportion at head office	OLS (1)	OLS - restricted (2)	Tobit - restricted (3)
Special arrangements	-0.14***	-0.11***	-0.14***
Primary	0.10***	0.07***	0.22***
manufacturing	0.09***	0.04***	0.09***
utilities	0.01	0.05*	0.12*
Construction	0.08***	0.10***	0.26***
Sales	0.01	0.05***	0.15***
Services	-0.05***	0.03**	0.08**
Financial/law	0.02	0.06***	0.14***
Health	-0.07***	0.07***	0.18***
Creative	-0.01	0.02	0.07*
Other	0.02	0.09***	0.26***
Rural hamlets and Isolated Dwellings in a sparse setting	0.03	-0.01	-0.06
Rural hamlets and isolated dwellings	0.04**	0.01	0.02
Rural town and Fringe in a sparse setting	-0.02	0.02	0.05
Rural town and Fringe	-0.00	0.01	0.03
Rural village in a sparse setting	-0.04	0.01	0.02
Rural village	-0.02	-0.00	-0.02
Urban city and town in a sparse Setting	-0.12*	-0.02	-0.09
Urban minor conurbation	-0.05**	-0.04***	-0.10***
Urban major conurbation	-0.01	-0.02**	-0.05**
Number of employees	-0.00	-0.00***	-0.00***
6-10	-0.19***	-0.17***	-0.42***
11-50	-0.30***	-0.34***	-0.69***
51-99	-0.35***	-0.50***	-0.89***
100+	-0.38***	-0.54***	-0.92***
North East	0.02	0.03**	0.02
North West	0.01	0.03***	0.04*
Yorkshire & Humberside	0.02	0.04***	0.07**
East Midlands	0.03*	0.05***	0.10***

West Midlands	0.03**	0.06***	0.12***
South West	0.03**	0.05***	0.11***
East	0.03**	0.05***	0.09***
South East	0.03**	0.06***	0.12***
Wales	0.01	0.10***	0.28***
Scotland	-	-	-
Sole proprietor	-0.01	0.09***	0.55***
Partnership	0.16***	0.05***	0.29***
Public Corporation	0.11**	-0.01	-0.08
Central Government Body	0.05**	-0.06***	-0.16***
Local Authority	0.18***	0.08***	0.12***
Non-profit Making Body	0.13***	0.04***	0.05*
Constant	0.53***	0.82***	1.16***
Observations	17,183	10,364	10,364
R-squared	0.12	0.38	
Probability>F=	0	0	
Pseudo R2			0.2401
Probability			0

source: ONS, ASHE and BSD

Results are broadly similar between models 1 and models 2. The main exception is that there are some sign changes in relation to the both sector and rural urban classification. Model 2 is preferred structurally as it omits those 'odd' enterprises with a potential shell company structure. When rerunning the regression model as a Tobit model, reassuringly the results are consistent with the second model, with only a couple of minor changes in relation to the level of significance of some of the control variables.

The main variable of interest is special arrangements. Controlling for all other factors, and in all specifications, the results show that those companies that have special arrangement in place (i.e., respond to ASHE electronically) have lower proportion of employees working at head office, and that this difference is significant at the 1% level. This provides clear support for our hypothesis that there is systematic measurement error in the reported work location when reporting using paper submissions.

In models 2 and 3, enterprises from all sectors compared to the public sector are more likely to report higher proportions of employment at their head office, with the sector controls all jointly significant at the 1% level. If we accept the premise that the response from the public sector (and health sector) is likely to be of the highest quality (Ritchie, 2001), this again provides further support

that there may be systematic mismeasurement and this is most common in a number of sectors from the private sector.

Confirming the results reported in Table 3, lower proportions work in the head office as the size of the company increases, although the effect is small. Excluding companies with zero HQ employment, both the OLS and censored regression results are significant at the 1% level. While in terms of local unit group size, the greater number of local units in an enterprise group (0-5 was the excluded group), the lower the proportion of head office employment - this result was again significant at the 1% level.

The regional variable shows that if an organisation has its head office in London (the omitted group) it has a lower proportion of employees registered as working in the head office. This may be explained by the increased cost of workspace and labour in London, making it more efficient for organisations to outsource work from the capital to its other work locations.

The results on registered status report that those working in sole proprietors, partnerships, local authorities and non-profit bodies all record higher proportions working at the head office than registered companies, while central government bodies have less.

In order to better understand the issue identified in Table 2 (i.e., having no-one as recorded as working at the head office), Figure 6 plots the binary distribution of the dependent variable – whether the enterprise records zero or some employment at the head office and Table 9 reports the results of a regression run on the probability of recording no one working at the head office.

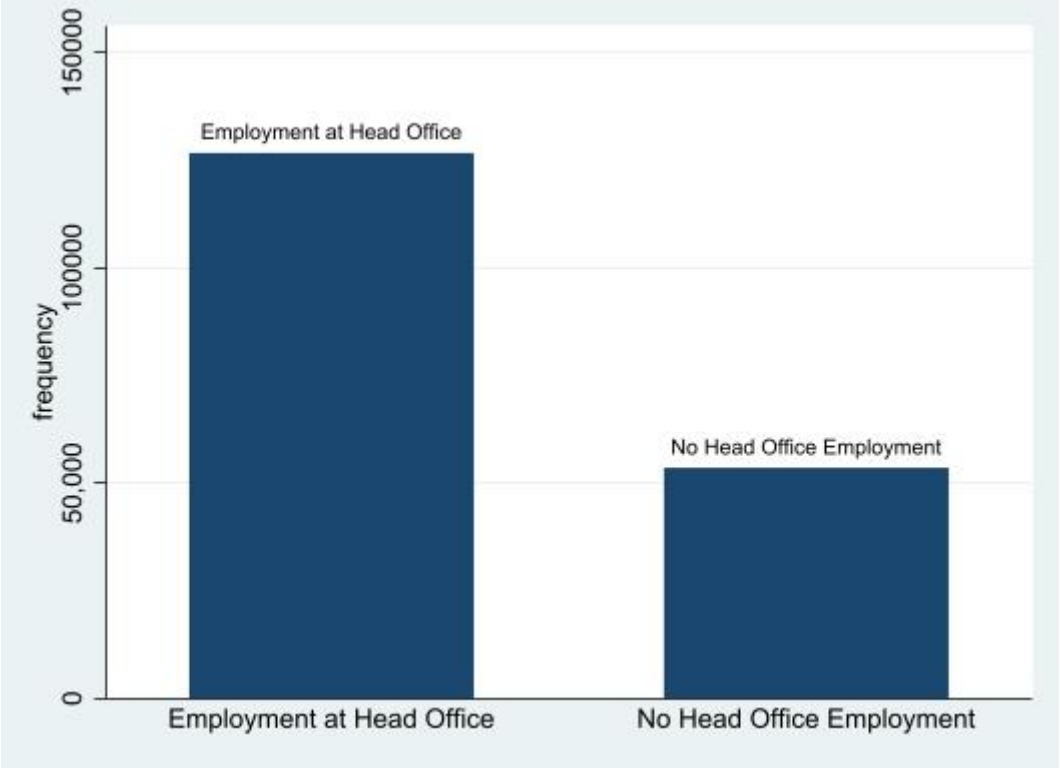

Figure 6: Number of individuals working for enterprises which has either some or zero head office employment

Source: ONS, ASHE

Figure 6 shows that just over 50 thousand of the 180 thousand individuals (30%) reported on in ASHE work for an enterprise which records no head office employment. While table 9 reports the regression results for which factors are more likely to influence this fact. The regression was run for just single site organisations, given the fact that conceptually a single site organisation by its nature should be a head office. From our earlier discussion, we believe that enterprises who are recorded as having no head office employment is either is due to an error/delay in processing or potentially may represent a shell company.

Table 9: Probability of having no one at the head office, single site only (2018)

Dependent variable: Probability of having no one at the HQ	Probit	Standard Error	t-statistic
Special arrangements	0.77***	0.14	5.46
Primary	0.18***	0.07	2.60
manufacturing	-0.14***	0.04	-3.17
utilities	0.10	0.09	1.09
Construction	0.16***	0.05	3.44
Sales	0.10**	0.04	2.40
Services	0.09**	0.04	2.17
Financial/law	0.23***	0.04	5.76

Health	0.23***	0.04	5.46
Creative	0.04	0.06	0.75
Other	0.10**	0.05	2.15
Rurual hamlets and Isolated Dwellings in a sparse setting	0.05	0.10	0.48
Rural hamlets and isolated dwellings	-0.09***	0.03	-3.29
Rural town and Fringe in a sparse setting	0.00	0.08	0.02
Rural town and Fringe	-0.04	0.03	-1.36
Rural village in a sparse setting	-0.28**	0.11	-2.49
Rural vllage	-0.06*	0.03	-1.90
Urban city and town in a sparse Setting	0.05	0.13	0.38
Urban minor conurbation	0.05	0.04	1.11
Urban major conurbation	0.05**	0.02	2.17
Number of employees	-0.00	0.00	-0.55
North East	0.02	0.04	0.38
North West	-0.02	0.03	-0.56
Yorkshire & Humberside	-0.01	0.03	-0.16
East Midlands	0.02	0.04	0.45
West Midlands	-0.03	0.03	-1.04
South West	0.00	0.03	0.07
East	-0.02	0.03	-0.48
South East	0.02	0.03	0.60
Wales	-0.00	0.04	-0.04
Scotland	-	-	-
Sole proprietor	-0.22***	0.03	-7.42
Partnership	-0.31***	0.03	-9.65
Public Corporation	-0.69*	0.38	-1.80
Central Government Body	-0.53***	0.06	-8.48
Local Authority	-0.38***	0.09	-4.33
Non-profit Making Body	-0.16***	0.03	-5.07
Constant	-0.72***	0.05	-15.30
Observations	41,027		
Psedo R2	0.014		
Probability	0		

Source: ONS, ASHE and BSD

The results suggest that controlling for all other factors, single site companies with special arrangements are more likely to record no head office employment. In other words, this is an enterprise that is large and complex enough to qualify for special arrangements but which does not appear to be operating from the registered business address. Although odd, this may reflect a complex company structure, as the BSD is reporting on the specific legal entity (enterprise), rather than the

overall corporate structure (enterprise group). There are, however, only a very small number of these observations (97 enterprises and 233 employees) and given that the full eligibility criteria for qualifying for special arrangements is not published by ONS, any interpretation is just conjecture.

In terms of sectors, the private sector (excluding manufacturing) and the health sector are more likely to record no head office employment than the non-health public sector. These estimates are significant at the 1% level for primary, construction, finance/law and health and at the 5% level for sales, services and other industries. The relationship for utilities and creative industries is calculated not to be statistically significant. If what we are picking up here is the existence of shell companies, as opposed to error in coding, this is unsurprising given that there is little incentive for a public sector company to establish a shell company, which are primarily used for tax incentives. Of all the sectors, the joint-largest coefficient is recorded for financial/law. Given its direct financial, legal and international focus, it is predictable that both these sectors would use legal and financial structures to limit their tax burden. Therefore, this provides some support for the hypothesis that those organisations without head office employment, first reported in Table 2, may be largely picking up the existence of shell companies.

Of all the other covariates, there is some support that rural businesses are less likely to report no one working at the head office than business in city and towns. The relationship with rural hamlets and isolated dwellings (2), rural village in sparse setting (5) and rural village all being significant between 1 and 10% level. Urban businesses in major conurbations, however, were more likely to report no one working at the head office than businesses in city and towns (significant at 5% level). This marked difference between rural and urban businesses may capture differences in business structure and provide support to the idea of (urban) businesses using complex shell structure arrangements. The registered status of a company further supports this inference, with register companies (omitted category) being more Lilley to record no head office employment compared with all other company structures (e.g. sole trader, partnership etc.) – all structures except public corporations are significant at the 1% level.

Individual level regressions – travel-to-work distance

To understand what factors influence the recorded distance that employees live away from work, the study reports a regression based on each individual ASHE return for the full sample (columns 1 and 2) and for a restricted sample using observations from employees working at multi-site companies (columns 3 and 4).

For all four models reported, errors are clustered to allow for multiple employees working at the same organisation. The dependent variables in column 1 and 3 are in actual terms (kilometres) and in logged terms for columns 2 and 4.

Table 10: Distance travelled to work, all employees and adjusted for enterprise clustering (2018)

	Distance - all observations		Distance- multisite only	
Dependent variable: distance travelled to work	Kilometres (1)	Logs (2)	Kilometres (3)	Logs (4)
Special arrangements	-9.59***	-0.16**	-9.50***	-0.16**
Single site	-6.02***	-0.27***		
Primary	4.84	0.18**	19.38*	0.55***
manufacturing	0.28	0.23***	4.23	0.33***
utilities	3.76	0.47***	5.72	0.59***
Construction	9.79***	0.67***	20.98***	1.01***
Sales	-3.67*	-0.01	-4.88	-0.02
Services	-3.71**	0.02	-5.00*	0.06
Financial/law	12.55***	0.58***	15.84***	0.67***
Health	-3.77**	-0.07*	-3.49*	-0.05
Creative	-6.13***	-0.11**	-9.13***	-0.20***
Other	1.31	0.11**	5.87	0.33***
Rural hamlets and Isolated Dwellings in a sparse setting	3.10	0.51***	-2.23	0.42***
Rural hamlets and isolated dwellings	3.50**	0.51***	2.21	0.47***
Rural town and Fringe in a sparse setting	-3.59**	-0.15**	-4.16*	-0.06
Rural town and Fringe	1.86	0.10**	2.30	0.10
Rural village in a sparse setting	3.59	0.35**	4.07	0.40**
Rural village	2.34	0.45***	1.63	0.43***
Urban city and town in a sparse Setting	-0.16	-0.10	-0.87	-0.03
Urban minor conurbation	1.37	0.09	2.85	0.09
Urban major conurbation	2.84**	0.13***	3.89**	0.15***
Number of employees	-0.01***	-0.00***	-0.01***	-0.00***
zero	-	-	-	-
6-10	5.40**	0.12***	5.32**	0.11***
11-50	10.50***	0.23***	10.48***	0.23***
51-99	15.13***	0.35***	15.62***	0.35***
100+	15.30***	0.17***	16.48***	0.19***
North East	-4.20	-0.32***	-5.06	-0.32***
North West	-6.18***	-0.34***	-7.57***	-0.34***
Yorkshire & Humberside	-7.60***	-0.38***	-9.33***	-0.37***

East Midlands	-6.06***	-0.30***	-6.49**	-0.26***
West Midlands	-5.23***	-0.26***	-5.05*	-0.22***
South West	-4.04	-0.36***	-3.17	-0.32***
East	-1.40	-0.19***	-0.56	-0.18***
South East	0.74	-0.16***	1.55	-0.15**
Wales	-6.70**	-0.28***	-7.03*	-0.24***
Scotland	-	-	-	-
Sole proprietor	-10.35***	-0.60***	-15.88***	-0.73***
Partnership	-11.06***	-0.50***	-16.26***	-0.48***
Public Corporation	3.58	0.20	4.24	0.23
Central Government Body	-7.57***	0.08*	-7.77***	0.14**
Local Authority	-20.96***	-0.30***	-21.10***	-0.23**
Non-profit Making Body	-4.86***	-0.01	-5.36**	0.07
Constant	25.51***	2.03***	24.12***	1.93***
Observations	151,448	151,448	102,869	102,869
R-squared	0.04	0.08	0.04	0.08
p	0	0	0	0

Source: ONS, ASHE and BSD

The results across all four model specifications appear robust, in as much as the coefficients generally all have the same sign. The logged model, however, appears a better fit given the heightened significance of a number of the control variables.

The results from the regressions provides additional support to the hypothesis that employees working for employers who make an ASHE paper submission are more likely to have their work location incorrectly recorded. This is because the main variable of interest, 'special arrangements' is significant across all four specifications. This result indicates that controlling for all other factors, individuals who work for enterprises with 'special arrangements' are recorded as working approximately 10km closer to work than individuals who have had their information provided using a paper submission. This finding is significant at the 1% level and holds both for the full sample and for just those employees working at multi-site enterprises. We conjecture that the reason for the discrepancy is that, in some instances, the ONS pre-filled postcode location in the paper questionnaires is actually the (regional) head office and not the workplace postcode for that employee.

The logged model supports this main assertion, indicating that employees who have had their information provided by 'special arrangements' live approximately 16% closer to their work than those

which don't, albeit the significance falls to the 5% level. This result has important implications for any analysis undertaken using ASHE's workplace variable.

The full models (columns 1 and 2) report that those who worked for a single site organisation lived approximately 6km, or 27%, closer to work than those who worked for multi-site employers. Given the assumption that the work location variable is correct for single site employers, and intuitively one may expect employees of multi-site companies to live closer to their employer, the contrary result suggest that caution should be shown when using the workplace variable for multi-site organisations.

While the logged model (columns 2 and 4), indicate that the sector is an important component in determining the distance travelled to work. For example, the results show that employees of seven of the 10 sectors for the multisite only models are recorded as working further away than public sector employees; all of which were significant at the 1% level. Indeed, construction workers who were likely to work more than double the distance from their work than public sector workers, with employees from the finance/law, utilities and primary sectors working over 50% further away. Given the expectation that the responses from public sector workers are likely to be of the highest quality, this further supports the assertion that there is systematic measurement error in the workplace location. The inference here is that ONS cease to include pre-recorded postcodes in their paper forms and should increase the coverage of companies using special arrangements. In an attempt to minimise any change to the current systems, ONS may wish only to initially expand the use of special arrangements for private sector companies in general, and construction, finance/law and utilities sector in particular.

Employees working for enterprises outside the main urban cities generally worked further away from home than those that worked in the main urban cities; this was significant for five of the nine urban/rural groupings. This is in line with Limtanakool et al. (2006) who analysed the national travel surveys for the UK and the Netherlands and concluded that urban structures contributed to long-distance commuting and business travel. Conceptually the result seems sound, but there is limited implication for workplace analysis from this observation.

In terms of size of employer, the results indicate that employees worked closer to their employer as the size of the employer increased. The regressions suggest that as the employer grew by 100 employees, employees work approximately 1km closer to their employer. Conceptually, this could be explained by the fact that large employers can become a monopsony employer within local markets, which in turn would limit distances travelled by its employees. Therefore, similarly to the urban/rural groupings, the size of employer has limited implication for workplace analysis.

The number of local units was an important factor in determining the distance travelled to work. The results suggest that the more local units a company has, the further away an employee lives from work. For example, compared with the base category (zero to five local units), those working for enterprises with 6-10 local units worked on average a further 5 km away, whereas those with 100 plus local units worked over 15km further away. This is counter intuitive to what we would be expected if there were no systematic measurement error in the workplace variable; therefore this result has important implications for researchers undertaking workplace analysis.

There is a strong regional effect with employees working for enterprises based outside London all travelling lessor distances to work than those who worked for organisations based in the capital (ranged from one to seven kilometres). Given the highly sophisticated transport infrastructure and labour markets of the capital, it is unsurprising that individuals are prepared to travel further distances to work in London.

The results in relation to registered status is inconclusive with sole traders, partnerships and local authorities all working closer than registered companies do. Whereas central government body employees worked further away, and all remaining structures were insignificant. As such, there are no obvious implications for improving the data.

5. Conclusion and discussion

Following discussions with NISRA, an analysis was undertaken to test whether there was any evidence of systematic measurement error in the ASHE data on workplace location, driven by multi-site companies incorrectly reporting the work location of employees.

In order to undertake the analysis four datasets were merged together. The merged datasets enabled the data for the same organisations to be compared between the ASHE and the BSD dataset. Descriptive statistics reported that employees working for the same organisation were more likely to be recorded as working in the head office in the ASHE dataset compared to the BSD dataset, and the difference increased with size.

When looking directly at just the ASHE sample, it revealed that employees working for multi-site organisations making paper submissions were recorded as living substantially further away from their registered work location than all other employees, including their conceptually closest group, multi-site organisations making electronic submissions. The analysis revealed that the differences grew with the size of the company, the number of local units and there were considerable sector differences, particularly between the private and public sectors. All of this evidence went some way to support the suggestion that multi-site firms providing paper ASHE submissions are more likely to

incorrectly report employment at the head office level, particularly for the largest employers with multiple local units.

Regression analysis confirmed the importance of special arrangements in reducing the probability of workers being reported as working in a head office and reducing the average distance an employee is recorded as living from their work. Employees of single site organisation worked closer than those who worked for multi-site employers; sector composition also appeared to have an influence, with employees in private sector companies, registered as working further away from work. The difference was most pronounced for individuals working in construction; finance and law; and utilities sectors. The number of local groups was an important factor in determining the distance travelled to work, with the more local units a company has the further away its employees were recorded as living from work.

The results provide consistent evidence in support of the original hypothesis that there is systematic measurement error in the reporting of work location for multi-site organisations using standard (paper based) reporting arrangements. As such, this has the potential to bias estimates of (regional) analysis undertaken using this variable.

Discussion

All these results are interesting in themselves, but the more important question is then how can the results of this analysis be used to address these issues and inform future research. Given the fact that it is not possible to observe the 'true' value of the workplace location, it is challenging to construct an accurate probability function to address the issue. However, a number of improvements are possible:

1. Create sub-samples based on the 'best' data on which to undertake analysis using the workplace location variable.
2. Inclusion of the paper questionnaire dummy in regressions
3. Numbers of local units should also be included in regressions as a control variable
4. In the medium-term, ONS can improve the data collection process so as the quality of the data for this variable improves in future vintages

An extreme approach researchers could take would be to include observations only from single site and multi-site organisations with special arrangements. This approach would exclude over half the number of observations (97,000) from approximately one third of all enterprises (18,314) and as such be subject to losing considerable valuable information.

However, to illustrate the effect of excluding the observations that are potentially subject to systematic measurement error, Table 11 shows the percentage reduction in the mean gross earnings of the high certainty sample (i.e. all observations excluding multi-site companies making paper submissions) with the full sample.

Table 11: Comparison of median annual gross wage between full sample and excluding multi-site companies making paper submissions.

Government Office Regions	Percentage reduction in mean gross earnings having removed multi-site companies making paper submissions
North East	16%
North West	12%
Yorkshire & Humberside	10%
East Midlands	7%
West Midlands	11%
South West	10%
East	7%
London	3%
South East	10%
Wales	15%
Scotland	7%

Source: ONS, ASHE

Table 11 shows that percentage decline in mean wages having removed the observations potentially impacted by systematic measurement error. All regions record a fall in the average mean wage rate; this is because some of the multi-site companies removed from the sample are the largest and most productive firms. However, given that the reduction in the ratio of mean gross wage is least pronounced for London (3 percentage points) compared with all other regions (e.g. 16 percentage

points for the North East), this supports the assertion that there may be systematic measurement error, leading to an underestimation of regional pay gaps.

The results from the regression, however, suggest the multi-site exclusions can be more subtle when a combination of others factors are also be taken into account. The regression analysis suggests that the three most important are sector (in particular the construction, finance/law and utilities sector), the number of local units and potentially regional location (e.g. London). By combing these factors, it would be possible to improving the quality of the sample but limit exclusions and loss of data (e.g. multi-site companies/ without special arrangements/ working in identified sector/ with over 100 local units/working in London). Given the potential to limit the systematic measurement error, by creating alternative sub-samples, researchers will be better able to test the robustness of their results, which ultimately should lead to better policy.

When undertaking regression analysis, the Inclusion of the paper questionnaire dummy in regressions would help to clean out some potential for measurement error. While region and sector are also important control variable, they are widely recognised as such and are generally used within the appropriate models. However, the number of local units are not often used and our analysis suggest that they should be in order to further limit potential bias in the estimates. This, of course will depends on the specific regressions and the questions being answered, but researchers should be aware of its potential importance as a control variable.

In the medium to longer term, however, in order to improve the quality of the workplace location data in ASHE, ONS should encourage more firms to switch to an electric submission of ASHE, and/or issue the paper survey without the work location already pre-filled. We are aware that moving to a blanket change overnight may be challenging, given the current systems in place, so ONS may wish to use a staged approached. ONS could potentially focus on the following groupings in a sequential order.

- Particular sectors most severally affected
- Enterprise with over a specified number of local units
- Businesses head quartered in London
- All private sector enterprise
- All enterprises

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Appendix 1: Qualify for special arrangements

Dependent variable: Qualify for special arrangements	OLS
Single site	-0.00*
Primary	-0.01***
manufacturing	-0.01***
utilities	-0.00
Construction	-0.01***
Sales	-0.01***
Services	-0.00**
Financial/law	-0.01***
Health	-0.01***
Creative	-0.01***
Other	-0.01***
Rural hamlets and Isolated Dwellings in a sparse setting	0.00
Rural hamlets and isolated dwellings	-0.00
Rural town and Fringe in a sparse setting	-0.01
Rural town and Fringe	-0.00
Rural village in a sparse setting	-0.00
Rural village	-0.00
Urban city and town in a sparse Setting	0.00
Urban minor conurbation	0.00
Urban major conurbation	0.00
Number of employees	0.00***
6-10	-0.00
11-50	0.00
51-99	0.01***
100+	0.06***
North East	0.01***
North West	0.00***
Yorkshire & Humberside	0.00**
East Midlands	0.00
West Midlands	0.00**
South West	0.01***
East	0.01***
South East	0.00
Wales	0.00
Scotland	-
Sole proprietor	0.00
Partnership	0.00

Public Corporation	0.04***
Central Government Body	0.03***
Local Authority	0.02***
Non-profit Making Body	-0.00
Constant	0.01***
Observations	58,210
R-squared	0.10
p	0

Appendix 2: Regressions for 2016

Table 8a Regressions on the proportion at head office, all multisite enterprises and multisite enterprises ignoring 'shell' companies (2016)

	(1)	(2)	(3)
	OLS	OLS - restricted	Tobit - restricted
Special arrangements	-0.07**	-0.09***	-0.10**
Single site	-	-	-
Unmatched	-	-	-
Primary	0.06	0.05*	0.15*
manufacturing	0.09***	0.02	0.04
utilities	-0.02	0.04	0.12*
Construction	0.04*	0.04***	0.11***
Sales	-0.00	0.04***	0.12***
Services	-0.05**	0.02*	0.08**
Financial/law	0.01	0.05***	0.14***
Health	-0.08***	0.05***	0.16***
Creative	0.01	0.04**	0.14***
Other	0.02	0.07***	0.25***
Rural hamlets and Isolated Dwellings in a sparse setting	-0.03	-0.05	-0.19
Rural hamlets and isolated dwellings	0.03*	0.01	0.04
Rural town and Fringe in a sparse setting	-0.13***	-0.04	-0.12
Rural town and Fringe	-0.00	0.01	0.03
Rural village in a sparse setting	-0.07	0.02	0.06
Rural village	0.00	-0.01	-0.03
Urban city and town in a sparse Setting	0.03	0.03	0.12
Urban minor conurbation	-0.06***	-0.02	-0.05
Urban major conurbation	-0.02*	-0.01*	-0.04*
Number of employees	-0.00	-0.00***	-0.00***
zero	-	-	-

6-10	-0.21***	-0.17***	-0.46***
11-50	-0.30***	-0.34***	-0.72***
51-99	-0.36***	-0.52***	-0.94***
100+	-0.39***	-0.59***	-1.01***
North East	-0.00	0.03**	0.04
North West	0.01	0.03***	0.04*
Yorkshire & Humberside	0.01	0.04***	0.07**
East Midlands	0.04**	0.06***	0.13***
West Midlands	0.01	0.06***	0.12***
South West	0.01	0.05***	0.10***
East	0.02	0.06***	0.12***
South East	0.03**	0.07***	0.16***
Wales	-0.00	0.08***	0.22***
Scotland	-	-	-
Sole proprietor	-0.05	0.05*	0.27***
Partnership	0.12***	0.04***	0.25***
Public Corporation	0.09*	-0.02	-0.10
Central Government Body	0.10***	-0.02*	-0.12***
Local Authority	0.17***	0.08***	0.13***
Non-profit Making Body	0.14***	0.04***	0.04*
Constant	0.55***	0.84***	1.21***
Observations	16,468	9,781	9,781
R-squared	0.12	0.41	
p	0	0	0
r2_p			0.261

Table 9a Probability of having no one at the head office, single site only (2016)

	(1)	(2)	(3)
	Probit	Standard errors	t-statistic
Special arrangements	0.10	0.16	0.66
Single site	-	-	-
Unmatched	-	-	-
Primary	0.18**	0.07	2.53
manufacturing	-0.10**	0.05	-2.12
utilities	0.15	0.11	1.39
Construction	0.23***	0.05	4.65

Sales	0.14***	0.05	2.98
Services	0.13***	0.04	2.90
Financial/law	0.27***	0.04	6.20
Health	0.22***	0.04	4.81
Creative	0.06	0.06	0.97
Other	0.17***	0.05	3.22
Rural hamlets and Isolated Dwellings in a sparse setting	-0.17	0.11	-1.58
Rural hamlets and isolated dwellings	-0.09***	0.03	-2.83
Rural town and Fringe in a sparse setting	0.09	0.09	1.05
Rural town and Fringe	-0.02	0.03	-0.81
Rural village in a sparse setting	-0.15	0.11	-1.35
Rural village	-0.06*	0.03	-1.84
Urban city and town in a sparse Setting	0.32**	0.13	2.52
Urban minor conurbation	0.07	0.05	1.59
Urban major conurbation	0.03	0.02	1.21
Number of employees	0.00	0.00	0.02
zero	-	-	-
6-10	-	-	-
11-50	-	-	-
51-99	-	-	-
100+	-	-	-
North East	0.01	0.04	0.15
North West	-0.01	0.03	-0.49
Yorkshire & Humberside	-0.03	0.03	-0.81
East Midlands	-0.03	0.04	-0.71
West Midlands	-0.04	0.03	-1.15
South West	-0.02	0.04	-0.57
East	-0.03	0.03	-0.82
South East	0.00	0.03	0.12
Wales	-0.01	0.05	-0.12
Scotland	-	-	-
Sole proprietor	-0.22***	0.03	-7.40

Partnership	-0.34***	0.03	-10.41
Public Corporation	-0.28	0.37	-0.76
Central Government Body	-0.51***	0.06	-8.13
Local Authority	-0.23**	0.09	-2.57
Non-profit Making Body	-0.15***	0.03	-4.64
Constant	-0.74***	0.05	-14.60
Observations	36,738		
r2_p	0.0155		
p	0		

Table 10a Distance travelled to work, all employees and adjusted for enterprise clustering (2016)

	(1)	(2)	(3)	(4)
	Kilometres	Logs	Kilometres	Logs
Special arrangements	-9.68***	-0.13*	-10.30***	-0.13*
Single site	-6.58***	-0.27***		
Unmatched	-	-	-	-
Primary	5.80	0.23**	12.33	0.45**
manufacturing	-1.76	0.20***	-0.52	0.23***
utilities	2.37	0.45***	2.88	0.50***
Construction	10.55***	0.66***	20.51***	0.93***
Sales	-5.21*	-0.07	-7.13*	-0.10
Services	-1.94	0.06	-2.50	0.12
Financial/law	11.70***	0.54***	13.92***	0.60***
Health	-8.19***	-0.19***	-10.09***	-0.24***
Creative	-8.23***	-0.24***	-11.06***	-0.35***
Other	0.58	0.05	3.68	0.25**
Rural hamlets and Isolated Dwellings in a sparse setting	1.39	0.45***	-2.63	0.30**
Rural hamlets and isolated dwellings	0.00	0.45***	-1.47	0.40***
Rural town and Fringe in a sparse setting	0.60	-0.11	2.10	0.01
Rural town and Fringe	0.39	0.06	-0.02	0.04

Rural village in a sparse setting	7.81**	0.36***	5.50	0.38**
Rural village	1.13	0.39***	-0.22	0.35***
Urban city and town in a sparse Setting	4.98**	0.03	7.31**	0.19
Urban minor conurbation	0.85	0.09	1.16	0.08
Urban major conurbation	2.54*	0.11***	3.90*	0.13***
Number of employees	-0.01***	-0.00***	-0.01***	-0.00***
zero	-	-	-	-
6-10	1.43	0.07**	1.32	0.07**
11-50	9.66***	0.25***	9.48***	0.25***
51-99	11.74***	0.33***	12.07***	0.33***
100+	16.46***	0.20***	17.17***	0.21***
North East	-1.97	-0.30***	-1.53	-0.28***
North West	-6.57***	-0.35***	-8.26***	-0.36***
Yorkshire & Humberside	-8.36***	-0.40***	-10.04***	-0.41***
East Midlands	-3.15	-0.25***	-2.32	-0.20**
West Midlands	-3.78	-0.25***	-3.54	-0.22***
South West	-0.96	-0.30***	-0.37	-0.26***
East	0.08	-0.16***	0.86	-0.15**
South East	-0.10	-0.18***	0.19	-0.18***
Wales	-8.50***	-0.29***	-9.79***	-0.28***
Scotland	-	-	-	-
Sole proprietor	-8.36***	-0.56***	-11.98***	-0.60***
Partnership	-8.97***	-0.48***	-13.70***	-0.44***
Public Corporation	5.91	0.31	5.36	0.33
Central Government Body	-3.88**	-0.17***	-2.58	-0.27***
Local Authority	-22.10***	-0.40***	-22.60***	-0.37***
Non-profit Making Body	-4.92***	-0.03	-5.57**	0.04
Constant	25.57***	2.04***	25.15***	1.98***

Observations	149,146	149,146	105,137	105,137
R-squared	0.05	0.08	0.05	0.09
p	0	0	0	0

Appendix 3: Regressions for 2017

Table 8b Regressions on the proportion at head office, all multisite enterprises and multisite enterprises ignoring 'shell' companies (2017)

	(1)	(2)	(3)
	OLS	OLS - restricted	Tobit - restricted
Special arrangements	-0.13***	-0.10***	-0.11**
Single site	-	-	-
Unmatched	-	-	-
Primary	0.04	0.04	0.13*
manufacturing	0.08***	0.03**	0.07**
utilities	-0.06	0.01	0.06
Construction	0.07***	0.06***	0.17***
Sales	0.00	0.04***	0.11***
Services	-0.05***	0.03**	0.09**
Financial/law	0.01	0.04***	0.10***
Health	-0.08***	0.06***	0.18***
Creative	0.01	0.03*	0.12**
Other	0.02	0.06***	0.19***
Rural hamlets and Isolated Dwellings in a sparse setting	0.03	-0.05	-0.17
Rural hamlets and isolated dwellings	0.03*	0.00	0.00
Rural town and Fringe in a sparse setting	-0.03	0.01	0.02
Rural town and Fringe	0.02	0.00	0.01

Rural village in a sparse setting	-0.08	0.01	-0.03
Rural village	-0.01	-0.00	-0.00
Urban city and town in a sparse Setting	-0.06	0.07	0.38*
Urban minor conurbation	-0.03	-0.03**	-0.09**
Urban major conurbation	-0.02*	-0.02***	-0.06***
Number of employees	-0.00	-0.00***	-0.00***
zero	-	-	-
6-10	-0.21***	-0.16***	-0.43***
11-50	-0.31***	-0.35***	-0.73***
51-99	-0.37***	-0.52***	-0.94***
100+	-0.39***	-0.56***	-0.97***
North East	-0.01	0.01	-0.02
North West	0.01	0.02*	0.03
Yorkshire & Humberside	0.00	0.02	0.03
East Midlands	0.02	0.05***	0.10***
West Midlands	0.02	0.05***	0.10***
South West	0.02	0.03***	0.07**
East	0.02	0.05***	0.11***
South East	0.03*	0.05***	0.11***
Wales	0.01	0.07***	0.21***
Scotland	-	-	-
Sole proprietor	0.00	0.07**	0.40***
Partnership	0.15***	0.05***	0.31***
Public Corporation	0.07	-0.04	-0.17**
Central Government Body	0.06***	-0.04***	-0.14***
Local Authority	0.17***	0.08***	0.13***
Non-profit Making Body	0.14***	0.05***	0.07***
Constant	0.55***	0.85***	1.23***

Observations	16,253	9,763	9,763
R-squared	0.13	0.41	
p	0	0	0
r2_p			0.257

Table 9b Probability of having no one at the head office, single site only (2017)

	(1)	(2)	(3)
	Probit	Standard errors	t-statistic
Special arrangements	0.67***	0.13	5.22
Single site	-	-	-
Unmatched	-	-	-
Primary	0.12*	0.07	1.65
manufacturing	-0.15***	0.05	-3.23
utilities	0.12	0.10	1.11
Construction	0.20***	0.05	4.23
Sales	0.09*	0.04	1.93
Services	0.11**	0.04	2.50
Financial/law	0.25***	0.04	5.96
Health	0.21***	0.04	4.76
Creative	0.04	0.06	0.73
Other	0.10**	0.05	2.09
Rural hamlets and Isolated Dwellings in a sparse setting	-0.08	0.10	-0.82
Rural hamlets and isolated dwellings	-0.10***	0.03	-3.40
Rural town and Fringe in a sparse setting	0.08	0.09	0.95
Rural town and Fringe	-0.03	0.03	-0.99
Rural village in a sparse setting	-0.15	0.11	-1.39
Rural village	-0.03	0.03	-1.10
Urban city and town in a sparse Setting	0.18	0.13	1.43

Urban minor conurbation	-0.00	0.05	-0.10
Urban major conurbation	0.05**	0.02	2.11
Number of employees	-0.01*	0.00	-1.84
zero	-	-	-
6-10	-	-	-
11-50	-	-	-
51-99	-	-	-
100+	-	-	-
North East	0.05	0.04	1.18
North West	0.01	0.03	0.44
Yorkshire & Humberside	0.00	0.03	0.01
East Midlands	0.01	0.04	0.14
West Midlands	-0.04	0.03	-1.10
South West	0.00	0.04	0.11
East	-0.03	0.03	-0.81
South East	-0.01	0.03	-0.29
Wales	-0.04	0.05	-0.98
Scotland	-	-	-
Sole proprietor	-0.22***	0.03	-7.14
Partnership	-0.30***	0.03	-9.30
Public Corporation	0.14	0.31	0.46
Central Government Body	-0.51***	0.06	-8.11
Local Authority	-0.23***	0.09	-2.69
Non-profit Making Body	-0.13***	0.03	-4.22
Constant	-0.71***	0.05	-14.40
Observations	37,163		
r2_p	0.0153		
p	0		

Table 10b Distance travelled to work, all employees and adjusted for enterprise clustering (2017)

	(1)	(2)	(3)	(4)
	Kilometres	Logs	Kilometres	Logs
Special arrangements	-12.77***	-0.23***	-13.05***	-0.23***
Single site	-5.12***	-0.24***		
Unmatched	-	-	-	-
Primary	0.84	0.15*	5.45	0.39**
manufacturing	0.48	0.24***	4.91	0.35***
utilities	3.40	0.49***	6.14	0.60***
Construction	10.35***	0.67***	21.50***	1.00***
Sales	-4.68*	-0.03	-5.61	-0.05
Services	-2.50	0.07	-2.61	0.13
Financial/law	11.61***	0.58***	15.35***	0.66***
Health	-3.76**	-0.09*	-3.82*	-0.09
Creative	-7.35***	-0.16**	-11.22***	-0.28***
Other	-0.54	0.04	3.42	0.26**
Rural hamlets and Isolated Dwellings in a sparse setting	5.59**	0.57***	0.62	0.39***
Rural hamlets and isolated dwellings	2.09	0.50***	1.77	0.47***
Rural town and Fringe in a sparse setting	-1.45	-0.14*	-2.13	-0.07
Rural town and Fringe	1.50	0.10**	1.54	0.09
Rural village in a sparse setting	7.71**	0.46***	8.53*	0.52***
Rural village	1.70	0.43***	-0.74	0.38***
Urban city and town in a sparse Setting	1.17	-0.02	1.56	0.05
Urban minor conurbation	1.55	0.11**	2.68	0.10
Urban major conurbation	4.13***	0.15***	5.33***	0.17***
Number of employees	-0.01***	-0.00***	-0.01***	-0.00***

zero	-	-	-	-
6-10	5.34**	0.10**	5.37**	0.10**
11-50	10.25***	0.24***	10.12***	0.24***
51-99	17.95***	0.40***	18.33***	0.41***
100+	16.78***	0.19***	17.88***	0.22***
North East	-0.60	-0.29***	-0.51	-0.28***
North West	-6.38***	-0.35***	-7.83***	-0.35***
Yorkshire & Humberside	-7.88***	-0.39***	-10.39***	-0.39***
East Midlands	-4.61*	-0.27***	-5.22	-0.24***
West Midlands	-4.57*	-0.25***	-5.03	-0.23***
South West	-4.25	-0.38***	-5.19	-0.37***
East	0.58	-0.15***	0.87	-0.14**
South East	2.09	-0.13***	2.71	-0.10*
Wales	-6.13**	-0.26***	-6.41*	-0.22***
Scotland	-	-	-	-
Sole proprietor	-10.05***	-0.61***	-11.96***	-0.66***
Partnership	-10.45***	-0.49***	-15.41***	-0.42***
Public Corporation	7.12	0.37	6.39	0.38
Central Government Body	-7.52***	0.11**	-7.08**	0.18**
Local Authority	-20.71***	-0.29***	-20.22***	-0.23**
Non-profit Making Body	-5.24***	-0.02	-5.18*	0.07
Constant	23.67***	1.98***	22.24***	1.89***
Observations	148,496	148,496	104,057	104,057
R-squared	0.05	0.08	0.05	0.08
p	0	0	0	0

Appendix 4: Regressions for pooled years (2016-2018)

Table 8c Regressions on the proportion at head office, all multisite enterprises and multisite enterprises ignoring 'shell' companies (2016-2018)

	(1) OLS	(2) OLS - restricted	(3) Tobit - restricted
Special arrangements	-0.12***	-0.11***	-0.13***
Single site	-	-	-
Unmatched	-	-	-
Primary	0.09**	0.08***	0.22***
manufacturing	0.09***	0.04***	0.10***
utilities	-0.02	0.02	0.06
Construction	0.07***	0.05***	0.12***
Sales	-0.00	0.04***	0.10***
Services	-0.06***	0.01	0.03
Financial/law	-0.00	0.04***	0.08***
Health	-0.08***	0.03***	0.08***
Creative	0.01	0.03	0.07**
Other	0.02	0.06***	0.16***
Rural hamlets and Isolated Dwellings in a sparse setting	0.04	-0.03	-0.10
Rural hamlets and isolated dwellings	0.03**	0.01	0.03
Rural town and Fringe in a sparse setting	-0.05	-0.03	-0.06
Rural town and Fringe	0.00	0.00	0.01
Rural village in a sparse setting	-0.08*	-0.03	-0.07
Rural village	-0.01	-0.01	-0.01
Urban city and town in a sparse Setting	-0.04	0.04	0.10
Urban minor conurbation	-0.03*	-0.03*	-0.06*
Urban major conurbation	-0.01	-0.01*	-0.03*
Number of employees	-0.00	-0.00***	-0.00***
zero	-	-	-
6-10	-0.20***	-0.17***	-0.34***
11-50	-0.29***	-0.34***	-0.57***
51-99	-0.35***	-0.49***	-0.73***

100+	-0.38***	-0.53***	-0.76***
North East	-0.00	0.03**	0.05*
North West	-0.00	0.01	0.01
Yorkshire & Humberside	0.00	0.03***	0.06***
East Midlands	0.03**	0.04***	0.08***
West Midlands	0.01	0.04***	0.07***
South West	0.01	0.04***	0.07***
East	0.02	0.04***	0.06**
South East	0.02**	0.05***	0.09***
Wales	-0.00	0.08***	0.17***
Scotland	-	-	-
Sole proprietor	0.01	0.08***	0.29***
Partnership	0.15***	0.08***	0.28***
Public Corporation	0.12**	-0.00	-0.02
Central Government Body	0.05***	-0.04***	-0.10***
Local Authority	0.18***	0.12***	0.18***
Non-profit Making Body	0.13***	0.05***	0.08***
2016	0.03***	-0.15***	-0.49***
2017	0.03***	-0.07***	-0.28***
Constant	0.52***	0.91***	1.44***
Observations	22,110	14,187	14,187
R-squared	0.12	0.35	
p	0	0	0
r2_p			0.226

Table 9c Probability of having no one at the head office, single site only (2016-2018)

	(1)	(2)	(3)
	Probit	Standard errors	t-statistic
Special arrangements	0.40***	0.12	3.45
o._Imultisite_0	-	-	-
o._Imultisite_2	-	-	-
_Isector_0	0.08	0.06	1.46
_Isector_1	-0.13***	0.04	-3.58
_Isector_2	0.06	0.08	0.77
_Isector_3	0.13***	0.04	3.37
_Isector_4	0.09**	0.04	2.47
_Isector_5	0.06*	0.03	1.65
_Isector_6	0.20***	0.03	5.93
_Isector_8	0.18***	0.03	5.26
_Isector_9	0.05	0.05	0.99

_Isector_10	0.08*	0.04	1.93
_Iwur_class_1	-0.06	0.08	-0.72
_Iwur_class_2	-0.09***	0.02	-3.71
_Iwur_class_3	0.07	0.07	1.09
_Iwur_class_4	-0.03	0.02	-1.38
_Iwur_class_5	-0.27***	0.09	-3.00
_Iwur_class_6	-0.04*	0.02	-1.89
_Iwur_class_7	0.17*	0.10	1.72
_Iwur_class_9	0.06	0.04	1.64
_Iwur_class_10	0.03*	0.02	1.72
num_ASHE_emp	-0.01***	0.00	-6.27
o._Ilu_grp_0	-	-	-
o._Ilu_grp_2	-	-	-
o._Ilu_grp_3	-	-	-
o._Ilu_grp_4	-	-	-
o._Ilu_grp_5	-	-	-
_Iregion_1	0.00	0.03	0.15
_Iregion_2	-0.00	0.02	-0.15
_Iregion_3	-0.02	0.03	-0.68
_Iregion_4	-0.02	0.03	-0.57
_Iregion_5	-0.04	0.02	-1.63
_Iregion_6	-0.00	0.03	-0.11
_Iregion_7	-0.02	0.03	-0.85
_Iregion_9	0.02	0.02	0.91
_Iregion_10	-0.01	0.03	-0.35
o._Iregion_11	-	-	-
_Iidbrsta_2	-0.23***	0.02	-10.31
_Iidbrsta_3	-0.29***	0.03	-11.40
_Iidbrsta_4	-0.25	0.32	-0.77
_Iidbrsta_5	-0.50***	0.05	-9.52
_Iidbrsta_6	-0.25***	0.07	-3.45
_Iidbrsta_7	-0.11***	0.02	-4.59
_Iyear_2016	-0.18***	0.01	-13.17
_Iyear_2017	-0.08***	0.02	-5.23
Constant	0.59***	0.04	-14.87

Observations	64,379
r2_p	0.0165
p	0

Table 10c Distance travelled to work, all employees and adjusted for enterprise clustering (2016-2018)

	Kilometres	Logs	Kilometres	Logs
Special arrangements	-10.83***	-0.18***	-11.11***	-0.18***
_Imultisite_0	-5.89***	-0.26***		
o._Imultisite_2	-	-	-	-
_Isector_0	3.86	0.19**	12.79*	0.47***
_Isector_1	-0.28	0.22***	3.04	0.31***
_Isector_2	3.17	0.47***	5.00	0.57***
_Isector_3	10.26***	0.67***	21.19***	0.99***
_Isector_4	-4.52**	-0.04	-5.80*	-0.06
_Isector_5	-2.66	0.05	-3.16	0.11
_Isector_6	12.01***	0.57***	15.21***	0.65***
_Isector_8	-5.18***	-0.11**	-5.65***	-0.12**
_Isector_9	-7.15***	-0.16***	-10.30***	-0.27***
_Isector_10	0.49	0.07	4.46	0.28***
_Iwur_class_1	3.34*	0.51***	-1.42	0.37***
_Iwur_class_2	1.89	0.48***	0.82	0.45***
_Iwur_class_3	-1.50	-0.14**	-1.37	-0.04
_Iwur_class_4	1.25	0.09**	1.26	0.08
_Iwur_class_5	6.37*	0.39***	6.07	0.43***
_Iwur_class_6	1.73	0.43***	0.24	0.39***
_Iwur_class_7	1.94	-0.03	2.63	0.07
_Iwur_class_9	1.27	0.09*	2.26	0.09
_Iwur_class_10	3.17***	0.13***	4.39***	0.15***
num_ASHE_emp	-0.00***	-0.00***	-0.00***	-0.00***
o._Ilu_grp_0	-	-	-	-
_Ilu_grp_2	4.09**	0.09***	4.03**	0.09***
_Ilu_grp_3	10.13***	0.24***	10.03***	0.24***
_Ilu_grp_4	14.94***	0.36***	15.33***	0.36***
_Ilu_grp_5	16.25***	0.19***	17.27***	0.21***
_Iregion_1	-2.23	-0.30***	-2.31	-0.29***
_Iregion_2	-6.34***	-0.34***	-7.84***	-0.34***
_Iregion_3	-7.93***	-0.39***	-9.91***	-0.39***

_Iregion_4	-4.59**	-0.27***	-4.66	-0.23***
_Iregion_5	-4.49**	-0.25***	-4.48	-0.22***
_Iregion_6	-3.04	-0.34***	-2.86	-0.32***
_Iregion_7	-0.21	-0.17***	0.44	-0.16**
_Iregion_9	0.92	-0.16***	1.50	-0.14**
_Iregion_10	-7.08***	-0.27***	-7.70**	-0.24***
o._Iregion_11	-	-	-	-
_Iidbrsta_2	-9.60***	-0.59***	-13.25***	-0.67***
_Iidbrsta_3	-10.15***	-0.49***	-15.07***	-0.45***
_Iidbrsta_4	5.66	0.30	5.35	0.32
_Iidbrsta_5	-6.34***	-0.12***	-5.83**	-0.20***
_Iidbrsta_6	-21.18***	-0.33***	-21.14***	-0.27***
_Iidbrsta_7	-4.99***	-0.02	-5.30**	0.06
_Iyear_2016	-0.97*	-0.03***	-1.06	-0.03*
_Iyear_2017	-0.44	-0.01	-0.59	-0.02
Constant	25.30***	2.03***	24.18***	1.94***
Observations	449,090	449,090	312,063	312,063
R-squared	0.04	0.08	0.05	0.08
p	0	0	0	0