Productivity, Investment and Profits during the Great Recession: Evidence from UK Firms and Workers*

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Abstract

The UK has recently experienced its deepest recession since the Second World War. One feature has been the resilience of employment, which fell far less than GDP. This led to a substantial fall in labour productivity and has given rise to a so-called 'productivity puzzle'. In this paper, we use firm- and individual-level data to shed new light on these aggregate patterns and we examine changes in firm investment in physical capital and profitability. We provide evidence that labour productivity, investment and firm profitability

all fell, on average, *within firms* over the course of the recession and that many of these adjustments were more pronounced in small firms. We also provide indicative evidence on the extent to which different firms might have engaged in labour 'hoarding'. Our results provide new insight into the potential determinants of the productivity puzzle and also indicate the types of firms that might be expected to be able to respond more quickly to a subsequent increase in demand.

Policy points

- Labour productivity and capital investment have fallen substantially *within firms*. This means that the changes to these factors that have occurred on aggregate within the economy cannot be explained by changes to the composition of firms alone.
- The changes to labour productivity that we observe appear to be driven by smaller falls in employment than might have been expected on the basis of changes to gross value added. We also find evidence of small reductions in weekly hours and much larger reductions in hourly wages. If firms were engaged in labour hoarding, then this provides a step towards, at least partially, understanding the productivity puzzle.
- Small and medium-sized firms have experienced larger proportionate falls in investment than larger firms. As our analysis focuses on firms that survive for at least two periods (and these results also hold for firms that survive the recession), this suggests that even established firms may have been facing credit constraints during this period, thus potentially providing support for policies to alleviate such constraints.

I. Introduction

The UK has recently experienced its deepest recession since the Second World War, with real GDP falling by 6.3 per cent between 2008Q1 and 2009Q2. One notable feature of this recession has, however, been the resilience of employment, which fell by just 2.1 per cent over the same period. As a result, labour productivity, as measured by real output per worker, has fallen substantially (see Figure 1) across the economy as a whole. This appears to have been at least partly driven by an increase in the proportions of part-time and under-employed workers, and hence a reduction in average hours worked,[1] but real output per hour worked has also fallen. This has given rise to a so-called 'productivity puzzle': why have labour inputs not fallen in line with output?

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[1]See Grice (2012), Patterson (2012) and Crawford, Jin and Simpson (2013).

FIGURE 1

Changes to output, employment and productivity in the UK since 2008
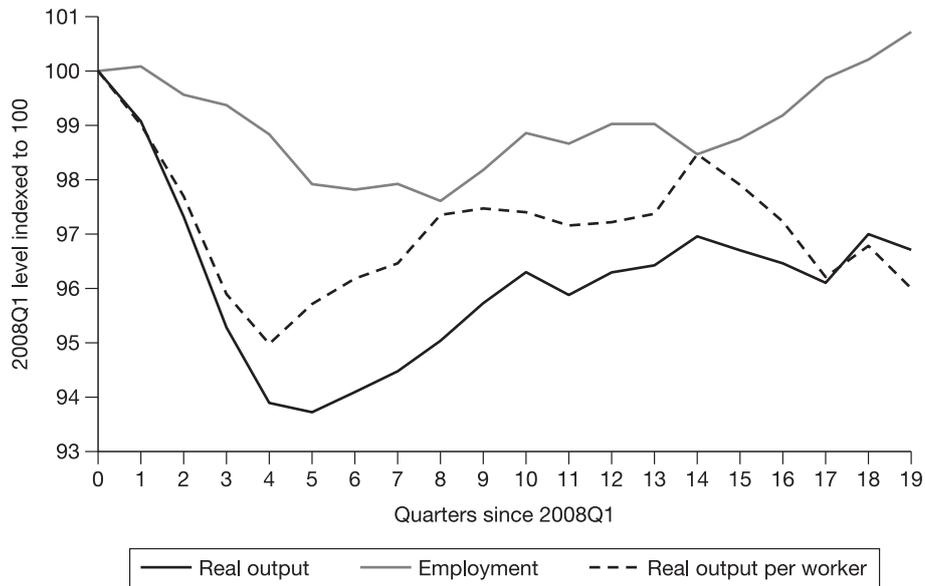
Note: Each of the three series is normalised to 100 at 2008Q1 (quarter 0). Real output is based on ONS series ABMI, which is real GDP seasonally adjusted; employment is based on ONS series MGRZ, which is the seasonally adjusted total in employment aged 16 and over. Real output per worker equals real output divided by employment.

Our paper contributes to a growing literature attempting to explain the 'productivity puzzle' in the UK.[2] One possible explanation for this puzzle might be that firms may have been trying to weather the recession by holding on to their workers and reducing their hours (and potentially also their wages), rather than making them redundant. This behaviour is sometimes thought to indicate 'labour hoarding'. Conceptually, labour hoarding refers to a situation in which firms continue to employ more labour than 'necessary' when faced with a negative demand shock – for example, because of adjustment costs. Employment protection and redundancy packages can make it costly for firms to fire workers, and firms that have cut their workforce during the downturn may then incur recruitment costs or struggle to fill their vacancies in a subsequent expansion. Firing workers may also lead to a loss of firm-specific knowledge, adding to the cost of training new recruits during the recovery.[3]

[2]See, for example, Grice (2012), Hughes and Saleheen (2012), Patterson (2012) and Goodridge, Haskel and Wallis (2013).
[3]The loss of specific skills was the main reason cited by UK employers for holding on to more labour than they needed in a recent survey by the Chartered Institute of Personnel and Development (2012).

In this paper, we use micro data on both firms and individuals to document firm behaviour and performance during the recession in terms of labour productivity, wages, hours worked and part-time employment.[4] We also create a measure of labour hoarding. What is not clear from the aggregate statistics or the literature on the productivity puzzle to date in the UK is whether the observed relationships are being driven by the changing composition of firms in the economy, or whether these changes are occurring within firms. This is important because any potential policy response might differ depending, for example, on the degree to which changes in aggregate productivity are driven by changes to the industrial composition of the economy, by entry and exit, or by existing firms (and workers) experiencing productivity falls. By using panel data on firms, we are able to track *within-firm* responses to the recession and examine whether and to what extent they vary according to firms' pre-recession characteristics, such as size and proxies for workforce skills.

We also contribute to the literature by examining changes in both investment and profitability across different firms during the recession. In order for firms to hoard labour while enduring a negative demand shock, they may reduce other expenditures such as investment or they may experience a fall in profits. Financial constraints during the recession may have also severely limited firms' ability to invest. For example, Benito et al. (2010) have shown that business investment fell very sharply between 2008 and 2010, while Carolan et al. (2012) demonstrated that gross fixed capital formation has been falling as a proportion of GDP since 2007; in both cases, these changes have been more dramatic than in previous recessions.[5]

Using data on a sample of UK firms and workers, we find that, within firms, real gross value added per employee (our measure of labour productivity) fell by around 3.2 per cent relative to a pre-recession trend. Firms acted to reduce employment and labour costs during 2008–09 as well: using individual-level data, we find evidence that this firm-level reduction in labour costs resulted from a very small adjustment to hours worked (of around 0.13 hours per week) and a much larger reduction in hourly wages. Relative to a pre-recession trend, average real hourly wages were around 5 per cent lower in 2009–11 than might otherwise have been expected. In particular, we find a 6.7 percentage point increase in the percentage of employees experiencing nominal pay freezes or cuts. This suggests that substantial reductions in wages might have permitted smaller decreases in employment or hours, leading to a reduction in labour productivity,[6] and

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[4]For our analysis using firm-level data, we only have access to data up to the end of 2009, whereas our individual-level data run to 2011. Hence our definition of the recession differs across our two analyses.

[5]See Benito et al. (2010) and Anagboso (2012).

[6]See also Blundell, Crawford and Jin (2013) on this issue.

hence that labour hoarding might provide a step towards an, at least partial, understanding of the productivity puzzle.

Our results also confirm the evidence from other recent UK studies that many of these changes appear more pronounced in small and medium-sized enterprises (SMEs).[7] If we treat them as indicators of labour hoarding, this suggests that SMEs (firms that have fewer than 250 employees) appear to be more likely to hoard labour than larger firms, which might be plausible if hiring and firing costs are greater for small firms.[8] If labour hoarding was occurring, then the findings also suggest that SMEs might be better placed to respond to a more positive economic climate as the economy exits recession.

Finally, we find evidence that, for our sample of firms, real investment fell by around 10 per cent relative to a pre-recession trend, with a greater fall among small and medium-sized firms than among larger firms. If this fall in investment contributed to a decrease in the capital–labour ratio within firms, then this might provide another potential explanation for the fall in labour productivity that we observe.[9] We also find that the likelihood of being in profit fell by 6.1 percentage points, on average, with larger firms experiencing slightly greater falls. The finding that SMEs appeared to exhibit greater falls in investment is consistent with them facing much more severe credit constraints during the financial crisis, which, if this were the case, would support policy aimed at improving credit flows for such firms.

The paper proceeds as follows. Section II describes the data and our empirical approach. Section III investigates changes in labour productivity, wages and employment over the course of the recession and how these vary by firm size. It also examines the relationship between the degree of labour hoarding and a variety of pre-recession firm characteristics. Section IV examines investment and firm profitability during the recession. Section V concludes.

II. Data and empirical approach

The aims of our analysis are to examine how labour productivity, firm investment and profitability have changed over the course of the recent recession compared with a pre-recession trend and to examine which pre-recession firm characteristics might help to explain these differences. We do so using both firm-level data and individual-level data. We discuss the data and methods used for both pieces of analysis in more detail below.

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[7]See Bank of England (2012) and Field and Franklin (2013).

[8]See Moscarini and Postel-Vinay (2012) for micro-level evidence on employment growth in small versus large employers over previous recessions for a number of OECD economies and for a discussion of how labour adjustment costs might vary for different types of firms over the business cycle.

[9]See Van Reenen (2013) for further discussion of this issue.

1. Data

The main data sets that we use are samples of firms, employees and workplaces in the UK from the Annual Respondents Database (ARD), the Annual Survey of Hours and Earnings (ASHE) and the National Employer Skills Survey (NESS) respectively.

The ARD is a micro-level business data set from which we calculate our main outcome of interest – labour productivity – as measured by real gross value added (GVA) per worker for each firm (or reporting unit).[10,11] It also provides other firm-level characteristics, including investment and labour costs, and enables us to construct a measure of profits (calculated as GVA minus labour costs). The ARD is close to being a census of large firms and contains a random sample of smaller firms each year. Firms can be linked over time using a firm-level identifier, but the sample design means that we are less likely to observe smaller firms year on year. We make use of data from 1997 to 2009. In the online appendix,[12] we discuss changes in the surveys underlying the ARD and how these affect our estimation sample. In particular, the number and composition of firms for which we observe both gross value added and number of employees (both of which we require in order to calculate real GVA per employee) have changed significantly over time.

Partly as a result, we focus our analysis on firms that appear more than once over the period we consider, meaning that our sample is likely to be biased towards larger and more productive survivors. Table 1 shows that this sample selection is not sufficient to overcome the bias in firm characteristics that we observe at different times, however: average real GVA per employee was apparently higher during the recession than it was before, while aggregate figures from the Office for National Statistics (ONS) suggest that productivity fell by 4 per cent between 2007 and 2009.[13] While we would not necessarily expect to be able to match productivity estimates derived from micro and macro data exactly[14] – not least because productivity is extremely difficult to measure and hence is likely to be measured with a large amount of error, particularly amongst public sector organisations

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[10]A reporting unit is the most disaggregated level at which we observe information such as labour costs and investment. This is the level at which businesses choose to respond to the survey. Most businesses report at a whole-enterprise level. But larger and more complex enterprises may have multiple reporting units. For example, in 2009, 259 out of 41,559 enterprises (0.6 per cent) in our sample have multiple reporting units. For simplicity, we use the term 'firm' interchangeably with the term 'reporting unit' in this paper.

[11]All relevant outcomes in ARD (for example, GVA, investment and labour costs) are deflated using GDP deflators at the SIC 2007 two-digit level.

[12]http://www.ifs.org.uk/docs/fsjun13_crawfordetal_appendix.pdf.

[13]Calculated using real GDP measured by ONS series ABMI and employment measured by ONS series MGRZ.

[14]See Field and Franklin (2013) for further discussion of this issue.

(which we exclude from our analysis for this reason) – the sizeable discrepancies that we observe are nonetheless concerning. With this in mind, we use fixed effect regressions to examine the drivers of within-firm changes in labour and capital inputs over the course of the recession, and remain agnostic about what explains the aggregate patterns. See Section II.2 for further discussion of our methods.

The ASHE is a 1 per cent random sample of employees in all industries in the UK, covering around 160,000 employees per year. It includes employees whose National Insurance number ends with a particular pair of digits, so the same individuals can be linked over time. It primarily contains information on earnings and hours worked, which is collected from employers. We use ASHE data from 1997 to 2011, in two ways. First, we use them to analyse changes to individual-level wage and employment outcomes. Second, we use data from ASHE aggregated to the region–industry–enterprise-size level as controls in our analysis of firm-level outcomes using the ARD data.[15] In both cases, we exclude observations in ASHE whose pay was affected by absence and whose reported hours and earnings are extreme.[16] Wages from ASHE are deflated using the retail price index (RPI).

The NESS is a workplace-level data set that contains information about the skills of employees at particular workplaces. The survey has been conducted every two years since 2001, covering around 80,000 workplaces on each occasion (although it is not a panel). Key variables covered include the number of employees by occupation, hard-to-fill vacancies, skill gaps and employees undertaking training. We use information from the 2007 survey as controls of pre-recession characteristics in our analysis of productivity. We construct these control variables at the industry–region–enterprise-size level.[17]

2. Empirical approach

For our analysis using the ARD data, our basic regression specification for all of our outcomes of interest is as follows:

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[15]For industry, we use one-digit SIC. For enterprise size, we use three bands: small (fewer than 50 employees), medium (50 to 249 employees) and large (250 or more employees). While it is possible in principle to link the two data sets directly using enterprise-level identifiers, in practice the resultant sample sizes are too small to produce robust analysis.

[16]We exclude those whose reported weekly hours are greater than 100 or whose reported hourly earnings are more than £1,000. The percentage of observations whose pay was affected by absence was just under 10 per cent every year until 2004 and about 5 per cent every year onwards, despite there being no change to the question. We therefore include an indicator for a sample break occurring in 2005 in our analysis using the ASHE data. See Section II.2 for details.

[17]Again, industry is defined by one-digit SIC. Enterprise size here has only two categories: fewer than 250 employees and 250 or more employees.

(1) $Y_{it} = \alpha_i + \beta Post08_t + \gamma Year_t + \delta Post06_t + u_{it}$

where Y_{it} is our outcome of interest for each reporting unit (*i*) in each year
(*t*); α_i are reporting unit fixed effects, designed to capture unobserved firm
characteristics that are relevant for our outcomes of interest and are constant
over time;[18] $Post08_t$ is a binary variable equal to 1 if the start of the survey
reference period falls in 2008 or 2009 and 0 otherwise (designed to indicate
a recession effect); $Year_t$ is a linear time trend; $Post06_t$ is a binary variable
equal to 1 if the observation falls in or after 2006 and 0 otherwise (designed
to capture the change in reference date for the collection of employment data
from December to September that occurred in 2006; see the online appendix
for full details); and u_{it} is an observation-specific error term.

   The main coefficient of interest is β, which reflects the average within-
firm change in the outcome of interest that occurred in 2008–09 relative to a
pre-recession linear time trend, which we interpret as the effect of the
recession on our outcome of interest.

   To construct a proxy measure for labour hoarding, we also run the
following simple specification on the pre-recession sample, where the
dependent variable is real GVA per employee, and then predict labour
productivity for observations in the recession period as long as the firm was
observed at least once in the pre-recession period:

(2) $Y_{it} = \alpha_i + \gamma Year_t + \delta Post06_t + u_{it}, \quad t < 2008$.

Then we calculate the difference between the prediction and the actual level
of real GVA per employee. This is interpreted as a firm's shortfall of
productivity relative to the pre-recession trend. The measure is scaled such
that a greater positive value means that actual labour productivity is further
below what one might expect based on the firm's past record.

   In addition, we run specification (2) on the outcome real GVA on the pre-
recession sample and predict real GVA for the recession period. We treat
firms whose actual GVA was lower than the prediction as the set that were
potentially subject to negative demand shocks. Conditional on this, our
constructed measure of productivity shortfall can be interpreted as a measure
of labour hoarding.

   In Section III.2, we look at how the measure of within-firm labour
productivity shortfall, or labour hoarding, during the recession correlates
with a set of pre-recession characteristics, both from the ARD and derived
from the ASHE and NESS data sets, in order to examine pre-recession
factors that might be associated with falls in labour productivity. In general,

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[18]The online appendix reports the main results with and without firm fixed effects and discusses the
sample issues in further detail (http://www.ifs.org.uk/docs/fsjun13_crawfordetal_appendix.pdf).

we average characteristics across all of the pre-recession periods in which we observe them.

We also conduct an analysis of hours and wages at the individual level using the ASHE data. To do this, we use a similar specification to (1):

$$(3) \qquad Y_{it} = \alpha + \beta Post09_t + \gamma Year_t + \delta Post05_t + u_{it}$$

where Y_{it} is our outcome of interest for each individual (i) in each year (t); $Post09_t$ is a binary variable equal to 1 if the observation falls in 2009–11 and 0 otherwise (designed to indicate a recession effect[19]); $Year_t$ is a linear time trend; $Post05_t$ is a binary variable equal to 1 if the observation falls in or after 2005 and 0 otherwise (designed to address a sample discontinuity that appeared to occur at this time; see footnote 16 for details); and u_{it} is an observation-specific error term.

Note that we do not include individual fixed effects in specification (3); hence the findings may partially reflect compositional changes in the workforce occurring as a result of the recession. In general, we expect the composition of the workforce to become more productive during recessions, as less productive workers are typically the first to leave.[20] In this case, we could potentially view our results as upper bounds on what has happened to wages and hours during the recent recession.

3. Descriptive statistics

This subsection provides some descriptive evidence on the sample of firms and workers that we use for our analysis and shows how the key outcomes of interest differ before and during the recession. Table 1 summarises this information from the ARD data, while Figure 2 summarises some of the key changes from the ASHE data.

As described above, Table 1 shows that, in our sample, labour productivity (as measured by real GVA per worker) appears to be substantially higher, on average, during the recession than in the preceding decade. While this might be plausible in a world in which there is substantial measurement error in productivity measures and/or there has been positive productivity growth over the intervening period, the fact that this contradicts published aggregate statistics on labour productivity suggests that the fundamental changes that have occurred to the design of the ARD sample[21]

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[19]Note that because the ASHE data are recorded in April each year and refer largely to the preceding financial year, information reported in April 2009 covers two-thirds of 2008 as well. It is for this reason that we start our recessionary period in 2009 in the ASHE data (rather than 2008 in the ARD data).

[20]See, for example, Blundell, Crawford and Jin (2013) for the recent recession in the UK.

[21]See the online appendix for more details (http://www.ifs.org.uk/docs/fsjun13_crawfordetal_appendix.pdf).

TABLE 1

Descriptive statistics: pre-recession and during the recession (ARD sample)

	Pre-recession (1997–07)		Recession[a] (2008–09)	
	Mean	*Median*	*Mean*	*Median*
Productivity level and shortfall relative to trend				
Number of employees in the firm	159.2	61.0	257.0	98.0
Real GVA (£m, 2008 prices)	6.3	1.8	13.0	3.6
Real GVA per employee (£'000, 2008 prices)	49.5	30.0	74.3	36.9
Labour costs per employee (£'000, 2008 prices)	24.9	21.0	31.8	26.8
Percentage of firms with actual real GVA below that predicted			52%	
Percentage shortfall of labour productivity relative to pre-recession trend[b]			4%	2%
Percentage shortfall of labour productivity relative to pre-recession trend,[b] conditional on GVA lower than predicted[c]			42%	27%
Binary indicator of labour productivity shortfall[d]			52%	
Binary indicator of labour productivity shortfall,[d] conditional on GVA lower than predicted[c]			77%	
Investment and profit				
Binary indicator of positive investment	77%		73%	
Real investment per employee (£'000, 2008 prices)	4.83	0.95	5.56	0.60
Binary indicator of making positive profit	87%		77%	
Number of observations	247,094		23,419	
Number of unique reporting units	85,276		19,214	

[a]We classify an observation as 'during the recession' if the start of the reference period falls in 2008 or later.
[b]Constructed by running equation (2), predicting labour productivity and calculating the percentage gap between predicted and actual labour productivity during the recession; positive values (i.e. actual GVA per employee being lower than predicted GVA per employee) are taken to indicate labour hoarding.
[c]Conditions on actual GVA being lower than predicted in an attempt to capture firms that faced negative demand shocks.
[d]Binary indicator equal to 1 if the labour productivity shortfall variable described above is positive and 0 otherwise.

might potentially bias our results if we do not properly account for this change in composition. We therefore rely on within-firm variation in order to identify our coefficients of interest.

As discussed in Section II.2, we construct measures of labour productivity shortfalls during the recession relative to firm-specific trends. This proxy measure of labour hoarding indicates on average a 4 per cent shortfall of labour productivity relative to the pre-recession trend across all firms in our sample observed during the recession period. The average shortfall rises to 42 per cent among firms whose real GVA was lower than predicted (i.e. amongst firms that were not expanding relative to previous

trends). We also construct a binary indicator variable, which takes the value 1 if a firm experienced a labour productivity fall. This shows that just over half of the firms in our sample appeared to experience a negative productivity shock during the recession. This figure increases to over three-quarters of those whose real GVA was below expectation.

Table 1 also shows that, even amongst our somewhat selective sample of firms, the percentage of firms making positive investments fell slightly during the recession, from 77 per cent to 73 per cent, and the percentage of firms making positive profits fell even more, from 87 per cent to 77 per cent.

Figure 2 shows the time trends in various measures of hours and wages derived from the ASHE data. The proportion of the workforce working part-time has been increasing steadily over the past decade and does not appear to have increased dramatically since 2008. Average weekly hours show a discontinuity in 2005[22] and fell slightly in 2009, but in both cases the changes are very small: less than half an hour on average per week.

Figure 2 also provides some evidence based on wage changes from one year to the next. Between 2009 and 2010, it shows that the average annual

FIGURE 2

Trends in ASHE measures of hours and wages
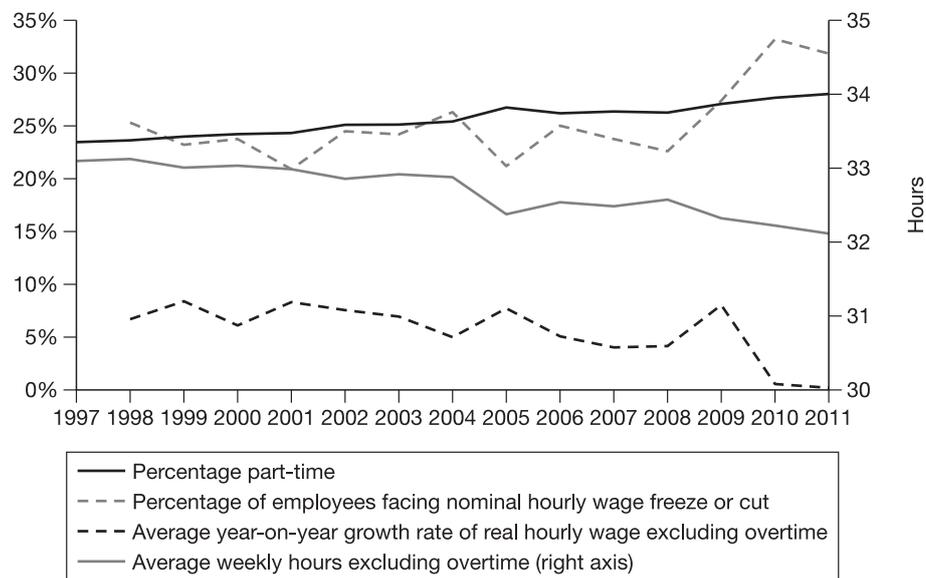
Note: The sample excludes individuals whose pay was affected by absence, whose hours or earnings are negative, whose weekly hours exceed 100 or whose hourly earnings exceed £1,000.

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[22]It appears that this jump in average hours between 2004 and 2005 is caused by the exclusion of employees whose pay was affected by absence, who tend to have lower hours. If such observations were included, average hours would increase slightly between 2004 and 2005.

growth rate of real hourly wages fell substantially. This was at least partly the result of low RPI inflation in 2009, which kept real wages artificially high at the start of the recession.[23] The proportion of employees experiencing nominal wage freezes or cuts also increased dramatically, by around 10 percentage points, from around 23 per cent in 2008 to around 33 per cent in 2010.

These descriptive statistics provide some suggestion that hours, wages, investment and profits were somewhat lower during the recession than on average over the previous decade. The next section goes on to estimate these relationships formally, to provide insight into the extent to which firm behaviour changed 'unexpectedly' relative to a pre-recession trend.

III. Labour productivity, employment and wages during the recession

1. Firm behaviour during the recession

Table 2 reports our estimates of the impact of the recession on firm-level labour productivity (as measured by real GVA per employee), real GVA, employment and labour costs per employee. These estimates are based on specifications including firm fixed effects; hence the effect of the recession is identified from within-firm variation.

TABLE 2

Impact of the recession on productivity, employment and labour costs (ARD data)

	(1) Log real GVA per employee	*(2)* Log real GVA	*(3)* Log no. of employees	*(4)* Log real labour costs per employee
*Post*08	–0.032***	–0.056***	–0.024***	–0.027***
	(0.007)	(0.007)	(0.004)	(0.004)
*Post*06	0.008	0.054***	0.046***	–0.022***
	(0.005)	(0.005)	(0.003)	(0.003)
Year	0.021***	0.026***	0.006***	0.033***
	(0.001)	(0.001)	(0.001)	(0.0004)
No. of obs.	270,513	270,513	270,513	269,724
No. of RUs	88,355	88,355	88,355	87,988

Note: Based on samples of reporting units (RUs) that appear at least twice between 1997 and 2009, excluding the top and bottom 1 per cent of RUs on the basis of GVA and number of employees. Standard errors are clustered by firm and given in parentheses. *** indicates significance at the 1 per cent level, ** at the 5 per cent level and * at the 10 per cent level.

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[23]The average growth rate of real hourly wages remained slightly above zero in 2010 and 2011 according to these data. If we exclude individuals for whom reported hourly wages more than doubled compared with the preceding year, then the average growth rate would drop slightly below zero but would remain substantially higher than the median growth rate, which is negative in both years.

Column 1 suggests that labour productivity during the recession was 3.2 per cent lower than might have been expected in the reporting units in our sample relative to their historical trend. Columns 2 and 3 show that there was a 5.6 per cent reduction in real GVA and a 2.4 per cent reduction in the number of employees per firm. Column 4 shows that real labour costs per employee fell by 2.7 per cent. This suggests both that firms may have reduced the size of their workforce and that remaining employees may be working fewer hours or for lower hourly wages or both.[24]

Table 3 shows the results from our individual-level regressions using the ASHE data. These suggest that adjustments to hours and wages are both plausible explanations for the observed reduction in average labour costs, although the changes to wages are much larger than the changes that we observe for hours. We find that, amongst employees, average weekly hours have fallen by about 0.13 hours relative to the pre-recession trend, whereas real hourly wages have fallen by 5.2 per cent relative to trend. Amongst individuals who were observed in two consecutive years, their year-on-year growth rate of real hourly wages dropped by 0.5 percentage points on average, and the likelihood of experiencing a nominal (real) wage freeze or cut increased by 6.7 (0.4) percentage points relative to the pre-recession trend respectively. The seemingly small impact of the recession on real wage growth is partly a result of low inflation in 2009.

TABLE 3

Impact of the recession on hours and wages (ASHE data)

	(1) Proportion of employees working part-time	(2) Weekly hours excluding overtime	(3) Real log hourly wage excluding overtime	(4) Year-on-year real growth rate of hourly wages excluding overtime	(5) Proportion of employees facing nominal pay freeze/cut	(6) Proportion of employees facing real pay freeze/cut
*Post*09	0.001	−0.128***	−0.052***	−0.005***	0.067***	0.004**
	(0.001)	(0.024)	(0.001)	(0.002)	(0.001)	(0.001)
*Post*05	0.006***	−0.354***	−0.013***	0.014***	−0.027***	−0.039***
	(0.001)	(0.028)	(0.002)	(0.002)	(0.001)	(0.002)
Year	0.002***	−0.015***	0.015***	−0.006***	0.003***	0.025***
	(0.0002)	(0.004)	(0.0002)	(0.0003)	(0.0002)	(0.0003)
No. of obs.	2,213,158	2,213,158	2,213,141	1,514,419	1,514,419	1,514,419

Note: 1997–2011. Main job only, i.e. the job with the highest weekly pay. Wages are deflated by annual RPI. Standard errors are given in parentheses. *** indicates significance at the 1 per cent level, ** at the 5 per cent level and * at the 10 per cent level.

[24]There could also have been a change in the composition of the workforce towards part-time or otherwise lower-paid workers.

Overall, these results suggest that the aggregate changes in labour productivity that have been observed by other commentators[25] are not just the result of changes in the composition of firms and workers over time, but also appear to be occurring within firms. This provides some suggestive evidence that the types of firms that are included in our sample – which, it must be remembered, is biased towards larger, more productive survivors – may be weathering the recession by reducing the wages (and, to a lesser extent, the hours) of their existing workforce rather than making them redundant.

Unfortunately, we do not have access to capital stock data, which would enable us to examine changes in total factor productivity as well. We experimented with including contemporaneous and lagged measures of real investment per employee in the specification in column 1 of Table 2. Although, as would be expected, we find a positive and significant relationship between investment intensity and labour productivity, the inclusion of these variables only marginally reduced our estimate of the effect of the recession to –0.030 and it remained highly statistically significant. Although the inclusion of a measure of investment intensity did not substantially affect our results, it is possible that changes in the capital–labour ratio play a role in explaining falls in labour productivity.[26]

Analysis by enterprise size

Bank of England (2012) and Field and Franklin (2013) both investigated the extent to which the aggregate changes in productivity that have been observed in the UK economy vary by size of enterprise; the former used company accounts information from the Financial Analysis Made Easy (FAME) database, while the latter used similar data to this paper (i.e. the ARD). Both concluded that productivity had fallen more in small enterprises than in larger enterprises over the course of the recession, but neither could distinguish between within-firm and compositional changes as the potential drivers of these differences.[27]

We build on their analysis by attempting to identify the extent to which within-firm changes in labour productivity, as well as a range of other indicators, vary by enterprise size. We split our sample into small enterprises (those with fewer than 50 employees), medium-sized enterprises (50 to 249 employees) and large enterprises (250 or more employees), and run separate regressions of specification (1) for each group.

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[25]For example, Grice (2012), Patterson (2012) and Field and Franklin (2013).

[26]See Van Reenen (2013) for further discussion of this issue.

[27]Field and Franklin (2013) found the strongest evidence of a negative relationship between firm size and labour productivity for ICT firms between 2007 and 2008 and for manufacturing firms between 2008 and 2009. The relationship is less strong for other service firms across both years.

We start by focusing on changes in real GVA per employee. The top panel of Table 4 suggests that there has been a 7.0 per cent fall in labour productivity among small enterprises relative to their pre-recession trend, a 3.6 per cent fall for medium-sized enterprises and little change for large enterprises. The differential fall in labour productivity by enterprise size appears to be driven by employment changes rather than changes to GVA. The second row of the top panel shows that GVA actually fell less in smaller enterprises. More strikingly, the third row suggests that the number of employees actually increased (by 3.3 per cent) over the course of the recession (relative to its pre-recession trend) within small enterprises, while it declined significantly (by 7.4 per cent) in large enterprises.

TABLE 4

Impact of the recession, by enterprise size (ARD data)

	Small (<50 employees)	Medium-sized (50–249 employees)	Large (≥250 employees)
	All firms		
Log real GVA per employee	−0.070***	−0.036***	−0.001
	(0.014)	(0.011)	(0.010)
Log real GVA	−0.037***	−0.053***	−0.076***
	(0.014)	(0.012)	(0.011)
Log number of employees	0.033***	−0.017***	−0.074***
	(0.009)	(0.007)	(0.007)
Log real labour cost per employee	−0.048***	−0.033***	−0.007
	(0.009)	(0.007)	(0.006)
No. of obs.	114,348	96,164	60,001
No. of RUs	50,234	26,042	12,079
	Firms that appear before and during the recession		
Log real GVA per employee	−0.076***	−0.046***	0.008
	(0.016)	(0.013)	(0.011)
Log real GVA	−0.130***	−0.139***	−0.123***
	(0.016)	(0.013)	(0.011)
Log number of employees	−0.054***	−0.093***	−0.131***
	(0.010)	(0.007)	(0.007)
Log real labour cost per employee	−0.023**	−0.021***	0.015**
	(0.011)	(0.007)	(0.006)
No. of obs.	22,641	35,810	36,390
No. of RUs	8,845	7,335	5,339

Note: Based on samples of reporting units (RUs) that appear at least twice between 1997 and 2009, excluding the top and bottom 1 per cent of RUs on the basis of GVA and number of employees. Sample for bottom panel further restricted to firms that appear both before and since 2008. Estimates of the effect of the recession on real GVA per employee obtained by running separate regressions for different enterprise sizes. Firms with zero employees are not included. Standard errors are clustered by firm and given in parentheses. *** indicates significance at the 1 per cent level, ** at the 5 per cent level and * at the 10 per cent level.

It is possible that this increase in employment among small enterprises is due to compositional changes in the sample because of entry and exit. For example, if (low-productivity) small enterprises are on average more likely to fail during the recession, then those that we observe surviving or even entering during this period might have higher levels of productivity or profitability. We investigated this possibility by restricting our estimation sample to those firms that appear in our sample both pre- and post-recession. The results of this exercise are shown in the bottom panel of Table 4. Using this sample of survivors, we find a 5.4 per cent fall in the number of employees within small enterprises. The other main change compared with the top panel of Table 4 is that reductions in real GVA are now much more similar across the three enterprise size categories. However, overall, we continue to find that larger enterprises experienced greater falls in employment, that small enterprises exhibited the greatest decreases in labour productivity and that it is differential changes in employment that seem to be underlying the latter.

TABLE 5

Impact of the recession, by enterprise size (ASHE data)

	Small (<50 employees)	*Medium-sized (50–249 employees)*	*Large (≥250 employees)*
Proportion of employees working part-time	0.009***	0.010***	–0.001
	(0.002)	(0.003)	(0.001)
No. of obs.	442,274	264,488	1,486,322
Weekly hours excluding overtime	–0.336***	–0.468***	–0.064**
	(0.057)	(0.061)	(0.028)
No. of obs.	442,274	264,488	1,486,322
Real log hourly wage excluding overtime	–0.093***	–0.066***	–0.037***
	(0.003)	(0.004)	(0.002)
No. of obs.	442,269	264,485	1,486,313
Real year-on-year growth rate of hourly wages excluding overtime	–0.012***	–0.010***	–0.002
	(0.004)	(0.003)	(0.002)
No. of obs.	280,000	173,293	1,048,564
Proportion of employees facing nominal pay freezes or cuts	0.128***	0.109***	0.045***
	(0.003)	(0.004)	(0.001)
No. of obs.	280,000	173,293	1,048,564
Proportion of employees facing real pay freezes or cuts	0.012***	0.003	–0.0002
	(0.003)	(0.004)	(0.002)
No. of obs.	280,000	173,293	1,048,564

Note: 1997–2011. Each cell reports the estimate and standard error for the *Post*09 dummy in a regression of the subsample divided by enterprise size. *** indicates significance at the 1 per cent level, ** at the 5 per cent level and * at the 10 per cent level.

In both samples, we also find that small and medium-sized enterprises (SMEs) had greater falls in labour costs per employee than large enterprises. Taken together with the results on employment changes, this indicates that smaller enterprises may have been acting to cut wages and/or hours rather than workforce headcount.

This picture is supported by the analysis of the ASHE data on individuals shown in Table 5. For example, we see that individuals employed in SMEs were more likely to be working part-time and experienced a larger reduction in average weekly hours and a larger reduction in average real wages than those employed in large enterprises. The average reduction in real wages may be due to compositional changes in the mix of employees working in these firms as well as lower real wages for existing employees. Amongst the set of individuals who are continuously employed, we find that the annual growth rate of their real hourly wages declined more for those in SMEs than for those in large firms. Also, the likelihood that individuals experienced a wage freeze or cut was greater for those employed in SMEs than for those in large firms.

Overall, the evidence presented in this subsection seems to support the findings for the aggregate economy from other studies – namely, that SMEs appear to experience bigger labour productivity falls (as measured by real GVA per worker) on average than larger firms. Moreover, this appears to arise at least partly as a result of within-firm changes to labour usage over the course of the recession: SMEs seem to be reducing per-worker labour costs more than larger firms, with substantially greater reductions (at least in percentage terms) to wages than to hours.

2. What characteristics are associated with falling labour productivity and labour hoarding?

The previous subsection showed that labour productivity – as well as employment, hours and wages – has fallen over the course of the recent recession (relative to a pre-recession trend) and that these changes appear to be more pronounced in smaller firms. To the extent that these measures can be thought of as indicators of labour hoarding, this suggests that firms, especially smaller firms, may have engaged in labour hoarding as a means of weathering the recession.

This subsection investigates a richer set of characteristics that might be associated with *the degree to which* firms experienced falls in labour productivity during the recession. To do this, we relate our continuous measure of labour productivity shortfall (described in Section II.2) to a variety of pre-recession characteristics, amongst firms whose actual GVA during the recession is below expectation, i.e. firms that may be constrained

TABLE 6

Examining variation in labour productivity shortfall: sample restricted to firms whose real GVA fell relative to predicted real GVA

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Pre-recession firm characteristics[a]								
Real log investment per employee	0.041***	0.003	0.002	−0.003	−0.003	−0.003	−0.003	−0.003
(plus a dummy for non-positive values)	(0.008)	(0.008)	(0.008)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Real log profit per employee		0.079***	0.080***	0.074***	0.074***	0.075***	0.075***	0.074***
(plus a dummy for non-positive values)		(0.010)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Real log labour costs per employee		0.097***	0.103***	0.112***	0.111***	0.112***	0.111***	0.110***
		(0.023)	(0.023)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
Pre-recession ASHE characteristics[b]								
at the region–industry–enterprise-size-band level								
Proportion of employees working part-time			0.217	0.328	0.367	0.215	0.258	0.417
			(0.340)	(0.355)	(0.360)	(0.356)	(0.361)	(0.380)
Proportion of employees not permanent			0.444	−0.040	0.023	0.084	0.114	−0.004
			(0.420)	(0.476)	(0.481)	(0.479)	(0.479)	(0.478)
Average weekly hours excluding overtime			0.0005	0.007	0.010	0.0004	0.002	0.012
			(0.014)	(0.015)	(0.015)	(0.015)	(0.015)	(0.016)
Proportion of employees working overtime			0.581**	0.487*	0.513*	0.565**	0.577**	0.487*
			(0.232)	(0.266)	(0.263)	(0.263)	(0.263)	(0.265)
Average year-on-year growth rate of hourly wages excluding overtime			0.128	−0.632	−0.464	−0.536	−0.523	−0.508
			(0.741)	(0.636)	(0.597)	(0.647)	(0.650)	(0.624)
Proportion of employees facing nominal hourly pay freezes or cuts			−0.348	−0.606	−0.626	−0.581	−0.561	−0.627
			(0.362)	(0.416)	(0.415)	(0.416)	(0.414)	(0.420)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Workplace characteristics in 2007 at the region–industry–enterprise-size-band level[c]								
Proportion of workplaces that trained any employees in the past 12 months				0.326*** (0.119)				0.181 (0.156)
Proportion of workplaces with any vacancies					0.362*** (0.119)			0.280 (0.173)
Proportion of workplaces with any hard-to-fill vacancies						0.270 (0.215)		−0.407 (0.317)
Proportion of workplaces with any skill-shortage vacancies							0.355 (0.231)	0.336 (0.379)
Number of observations	10,149	10,149	10,146	8,243	8,243	8,243	8,243	8,243
R-squared	0.043	0.061	0.063	0.066	0.066	0.065	0.065	0.065

[a]Averaged across all observations of the firm before 2008 and then expressed in logarithms.

[b]Averaged across all observations within the cell during 1997–2007.

[c]F-statistic for the joint significance of the four workplace characteristics in the last column is 3.15; p-value = 0.014.

Note: All regressions include log of average pre-recession enterprise size and industry, region and enterprise-size-band dummies. Labour productivity shortfall estimated based on a sample of reporting units (RUs) that appear at least twice between 1997 and 2009, excluding the top and bottom 1 per cent of RUs on the basis of GVA and number of employees. Estimation sample then restricted to those firms whose real GVA fell relative to expected. Standard errors are given in parentheses and are clustered by industry–region–enterprise-size-band. *** indicates significance at the 1 per cent level, ** at the 5 per cent level and * at the 10 per cent level.

on the demand side.[28] Some of the characteristics we use are from the ARD data and hence vary at the firm level, while others are derived from the ASHE and NESS surveys and hence vary at more aggregate levels (i.e. region–industry–enterprise-size-bands; see Section II.1). The aim of this exercise is to identify characteristics that are correlated with the extent of labour productivity falls, or labour hoarding, rather than to estimate the causal impact of these characteristics per se.

Table 6 presents the results of this analysis. Overall, they suggest that measures of firms' pre-recession profits and average labour costs per employee are strong predictors of the extent of labour productivity shortfall, or labour hoarding, during the recession. Column 1 of the table suggests that the degree to which firms' labour productivity fell is higher in firms with higher pre-recession investment intensity (investment in physical capital per employee). However, once we control for average pre-recession profits and labour costs per employee in column 2, the coefficient on investment intensity becomes statistically insignificant. The estimates in column 2 suggest that a 1 per cent increase in pre-recession profits is associated with a 0.08 per cent increase in our labour productivity shortfall measure during the recession and that a 1 per cent increase in pre-recession labour costs per employee is associated with a 0.1 per cent increase in the labour productivity shortfall measure.

These estimates do not change significantly if we additionally control for other characteristics derived from the NESS and ASHE, as in the middle and bottom panels of Table 6. Interpreting our labour productivity shortfall measure as a proxy for labour hoarding, it is highly plausible that firms that have accumulated more profits before the recession were better placed to hoard workers. It is also possible that firms with exceptionally high levels of profit per employee were overstretched before the recession and may therefore have more scope for their labour utilisation to fall. The measure of labour costs per employee can be thought of as indicative of the average skill level of a firm's workforce. Again it is intuitive that firms with a more highly skilled workforce may be more inclined to hold on to their workers during temporary downturns. If these workers possess firm-specific skills, they may be harder to replace. We investigate this hypothesis further in the bottom panel of Table 6 using NESS data on training and vacancies.

The second panel of Table 6 shows how our measure of labour productivity shortfall correlates with a range of employee characteristics including average hours and wage growth, measured at the region–industry–enterprise-size-band level. Note that we already include dummies for region, industry and enterprise size band, so the estimates rely very much on

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[28]The prediction of GVA is based on a model regressing GVA (from 1997 to 2007) on a linear time trend, the *Post*06 indicator and reporting unit fixed effects. Our sample is also therefore based on firms that we observe both before and during the recession.

variation within industry, region and enterprise size band. Only one of the employee characteristics in the table is statistically significant – the proportion of employees working overtime before 2008 appears to be positively correlated with our measure of labour productivity shortfall during the recession. Again, it seems intuitive that firms that were overstretched before 2008 might see greater decreases in labour productivity during the recession.

In the final panel of Table 6, we show how our measure of labour productivity shortfall correlates with pre-recession measures of training and vacancies at the region–industry–enterprise-size-band level. All estimates are conditional on the previous sets of characteristics. We begin by including each variable individually since they are very highly correlated. The estimates in columns 4 and 5 suggest that the measures of the incidence of workplace training and of the proportion of workplaces with general vacancies are positively correlated with our proxy for labour hoarding; however, they lose statistical significance once we include the full set of measures from the NESS in column 8. The directions of associations are again intuitive: for example, a higher incidence of training is positively associated with our proxy for labour hoarding, perhaps because firms that trained their staff have a bigger incentive to retain them during temporary downturns. In addition, having vacancies of any type may be positively associated with our measure of labour productivity shortfall because having vacancies in 2007 could mean the firm was overstretched then and hence had more scope for labour productivity to fall during the recession.

Overall, these results suggest that the degree of labour hoarding (the productivity shortfall amongst firms experiencing a negative demand shock) is higher amongst firms with higher pre-recession profits, as well as amongst those with a more skilled workforce on various measures.

IV. Profitability and investment

We saw above that labour productivity – as well as employment, hours and wages – appears to have fallen during the recent recession (relative to a pre-recession trend) and that these changes appear to have been more pronounced in smaller firms. In this section, we investigate whether similar patterns are evident in terms of firms' real investment (as measured by net capital expenditure) and likelihood of making a profit (i.e. having a positive surplus of GVA over labour costs). Table 7 presents the results for investment, while Table 8 presents the results for profitability.

The results in column 1 of Table 7 indicate that investment was, on average, 10 per cent lower during the recession than its pre-recession trend would have suggested. The results in columns 2 to 4 imply that the estimated

TABLE 7

Impact of the recession on firm investment (ARD data)

	(1) All firms	*(2)* Small (<50 employees)	*(3)* Medium-sized (50–249 employees)	*(4)* Large (≥250 employees)
*Post*08	−0.099***	−0.107***	−0.157***	−0.042*
	(0.015)	(0.035)	(0.024)	(0.024)
*Post*06	0.131***	0.115***	0.139***	0.135***
	(0.013)	(0.027)	(0.019)	(0.022)
Year	−0.046***	−0.044***	−0.048***	−0.045***
	(0.002)	(0.003)	(0.002)	(0.003)
No. of obs.	208,169	77,145	79,752	51,272
No. of RUs	75,772	40,253	24,349	11,170

Note: All estimates are based on a sample of reporting units (RUs) that appear at least twice between 1997 and 2009, excluding the top and bottom 1 per cent of RUs according to GVA and number of employees. Standard errors are clustered at the firm level and given in parentheses. *** indicates significance at the 1 per cent level, ** at the 5 per cent level and * at the 10 per cent level.

within-firm fall in investment was larger in small and medium-sized enterprises than in large enterprises. If we restrict our sample to firms observed both before and after 2008 (which we therefore know survived into the recession), the estimated recession effects become more negative but we continue to find that SMEs saw greater falls in real investment per employee than larger enterprises.

Table 8 shows the results for the likelihood that a firm makes a positive surplus during the recession. There appears to be a negative relationship between enterprise size and the probability of being in profit, with large

TABLE 8

Impact of the recession on the probability of making a profit (ARD data)

	All firms	Small (<50 employees)	Medium-sized (50–249 employees)	Large (≥250 employees)
*Post*08	−0.061***	−0.042***	−0.060***	−0.078***
	(0.004)	(0.007)	(0.006)	(0.007)
*Post*06	−0.005*	−0.011**	−0.003	0.002
	(0.003)	(0.005)	(0.004)	(0.005)
Year	−0.006***	−0.003***	−0.006***	−0.008***
	(0.0004)	(0.001)	(0.001)	(0.001)
No. of obs.	270,361	114,330	96,133	59,898
No. of RUs	88,345	50,231	26,041	12,073

Note: All estimates are based on a sample of reporting units (RUs) that appear at least twice between 1997 and 2009, excluding the top and bottom 1 per cent of RUs according to GVA and number of employees. Standard errors are clustered at the firm level and given in parentheses. *** indicates significance at the 1 per cent level, ** at the 5 per cent level and * at the 10 per cent level.

enterprises being 7.8 percentage points less likely to make a profit in 2008 or 2009 (relative to a pre-recession trend) compared with just a 4.2 percentage point reduction for small enterprises. This does not appear to be the result of larger enterprises being more likely to make a profit before the recession and a convergence since then; in fact, large enterprises in our sample were, on average, slightly less likely to make a profit before the recession than smaller ones. The results are very similar if we restrict the sample to firms that are observed both before and during the recession.

Overall, these results suggest that, during the 2008–09 recession, firms were economising not only in terms of labour inputs but also in terms of capital inputs. The finding that SMEs experienced greater falls in investment intensity implies that these firms, which might have been more reliant on external finance, are likely to have been facing particularly acute credit constraints during the recession, with the nature of the financial crisis and the effects on the banking sector having made banks highly reluctant to lend, even to established firms.

V. Conclusions

This paper has used micro data on firms and individuals to provide a picture of firms' responses to the recession and to document how this varied according to firms' characteristics. We find strong evidence that labour productivity fell within firms during the recession. We also find evidence of differential behaviour across firms of different sizes. Our evidence suggests that small and medium-sized firms experienced greater falls in labour productivity and investment per worker than larger firms. The latter finding suggests that smaller firms may have been facing particularly severe credit constraints during this period, which could potentially back the need for policies aimed at increasing the flow of external finance to smaller firms.

We also investigated one potential explanation (or partial explanation) for the so-called productivity puzzle: the possibility that firms may have been hoarding labour. If this were the case, then the falls in productivity per worker and per hour that we have seen over the course of the recent recession in the UK could be explained by firms continuing to employ more workers than strictly 'necessary' in order to meet their current demand. Using data on individuals and firms, we found evidence in line with this behaviour: firms were acting to maintain (or at least only slightly reduce) the size of their workforce, but at the same time cutting their labour costs per employee by reducing nominal wages and, to a lesser extent, weekly hours.

Using a firm-level proxy measure for labour hoarding (productivity shortfalls amongst firms experiencing negative demand shocks), we find a positive association between this measure and firms' pre-recession profits, average labour costs per worker, and the prevalence of employee training

and staff vacancies before the recession. Taken together, these results support the idea that those firms experiencing falls in labour productivity may have been engaged in labour hoarding, and that they may have been trying to retain higher-skilled or more experienced staff in order to be better placed to respond to a pick-up in economic conditions.

In terms of potential policy implications, our results suggest that many of the aggregate changes to productivity and investment that have been observed by other commentators[29] occurred within firms and hence cannot be explained only by changes to the composition of workers or firms in the economy. This is supported by other work in this area.[30] In terms of investment, our results suggest that even established firms may have been facing credit constraints during this period (or that they cut back on their investments for other reasons), thus potentially providing support for policies to alleviate such constraints. As discussed by other commentators,[31] this reduction in investment may have contributed to a fall in the capital–labour ratio, which might help to explain the reduction in labour productivity that we observe. It is also clear, however, that falling labour productivity has been accompanied by falling nominal and real wages within firms.

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[29]For example, Grice (2012), Patterson (2012) and Field and Franklin (2013).

[30]For example, Blundell, Crawford and Jin (2013).

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