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Abstract

In many larger advanced economies labour productivity growth slowed sharply and remained subdued for years after the credit crisis of 2007/08. Nowhere was this more obvious than in the UK. We examine the dynamics of productivity among British businesses that lie behind this stagnation. The most striking feature is the widespread weakness in total factor productivity *within* firms, pointing to the importance of a common factor in explaining productivity weakness. In addition, we find that the positive correlation between surviving firms' employment growth and their relative productivity ranking broke down after 2007/08, as would be expected if an adverse credit supply shock had caused inefficiencies in resource allocation across firms. Indeed, during the immediate recession years 2008/09, this shift was most apparent in sectors with many small and bank dependent businesses. But subsequently, while the contribution of external reallocation to aggregate productivity growth in 2010/13 was smaller than in previous years, this was not obviously associated with sectoral bank dependence. We illustrate the sensitivity of these findings to the choice of decomposition method.

Keywords: productivity growth, productivity decomposition, resource allocation, credit shock, Great Recession, Great Stagnation.
JEL codes: L11, O47, E32

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1 INTRODUCTION

Recovery from the recessions that occurred across advanced economies in the wake of the credit crisis of 2007/8 was a slow process, and in many economies a key feature of the recovery was the failure of productivity to rebound. In the six years after the financial crisis average annual labour productivity growth in both France and Germany was 1½%-points less than in the previous ten years (Figure 1) so that by 2013, five years after the acute phase of the financial crisis, labour productivity remained around 10% below a simple extrapolation of the previous trend. In the US, Canada, Italy and Japan the shift in productivity growth was less pronounced, about half that of Germany and France. Nowhere was productivity weakness more evident than in the UK, where in 2013 the gap between trend and actual labour productivity stood at around 16%. This picture contrasts very sharply with the experience of other post-war UK recessions, when the drop in productivity was less steep and recovery quicker.

The financial crisis of 2007/8 originated in the US sub-prime mortgage market, but this quickly developed into widespread difficulties in international credit markets (Helbling *et al.*, 2010; Eickmeier *et al.*, 2013) and restrictions in bank lending to non-financial corporations (Iyer *et al.*, 2014). The contraction in bank lending to corporations was particularly marked in the US and the UK (Figure 2) and, unlike the experience in the US, Germany and France, bank lending to the corporate sector in the UK continued to contract long after the acute phase of the credit crisis. By 2013 the stock of real bank debt held by UK corporations was more than 20% below its peak before the crisis, much of which reflected a tightening of credit supply (Bell & Young, 2010).

While the weakness in UK productivity is not well understood, the tightening of credit conditions points to one possible contributing factor. The literature suggests that recessions accompanied by a financial crisis tend to be both deeper and longer lasting in terms of output losses than normal recessions (Hoggarth, Reis & Saporta, 2002; Cerra & Saxena, 2008; Cecchetti, Kohler & Upper, 2009; Reinhart & Rogoff, 2011). One hypothesis is that a banking crisis reduces the efficiency of resource allocation across businesses, thereby hindering one of the key mechanisms through which productivity growth arises.[1] For example, in a banking crisis, firms that rely on banks to finance their activities become credit constrained, which may prevent

[1] The process whereby highly productive firms gain market share and less productive firms either lose market share or go out of business is thought to be a crucial driver of productivity gains. See, for example, Foster, Haltiwanger & Krizan (2001) and Baily, Bartelsman & Haltiwanger (2001) for the US. Perhaps the most influential study for the UK is Disney *et al* (2003). They analyse labour and TFP growth in British manufacturing from 1980 to 1992 and reach similar conclusions to their US counterparts. Using the same dataset that we use here they find that external restructuring (i.e. the net effect of firm entry and exit and changes in market shares of surviving firms) accounts for around 50% of establishment labour productivity growth and 80-95% of establishment TFP growth. Bartelsman, Haltiwanger & Scarpetta (2013) suggest that cross country differences in allocative efficiency imply substantial differences in cross-country productivity performance.

them from expanding their otherwise viable operations.[2] New firms may be unable to enter the market if this requires a capital outlay upfront, reducing competitive pressures on incumbent firms, and banks may forbear bad debtors in an effort to preserve their own balance sheets, thereby delaying the process of company closure.[3] However, despite some compelling arguments and traction with policymakers (see e.g. Broadbent, 2012, and Barnett *et al.*, 2014a), there is relatively little evidence on the importance of these types of distortions to resource allocation in explaining productivity weakness in the context of banking crises and hence on the appropriate remedial action for policy.

Against this background this article maps productivity developments amongst establishments in Britain before and after the global credit crisis. The objective is to gain a better picture of what has been occurring at the micro-level, which underpins developments in aggregate productivity. While this descriptive analysis is of interest in its own right, our focus is on gauging to what extent inefficiencies in resource allocation across businesses help to explain the weakness of UK labour productivity in the aftermath of the global financial crisis. Specifically, we document how the weakness of productivity growth in the UK between 2007 and 2013 can be accounted for by shifts in productivity within firms and by changes in the composition of the business population, respectively. This is a straightforward accounting exercise. We use a dynamic decomposition method first proposed by Diewert and Fox (2010), which, in comparison to more widely used decomposition methods, avoids conflating cyclical changes in aggregate productivity with changes in the productivity contributions of resource allocation, and is relatively robust to measurement error. We briefly discuss alternate and more widely used decomposition techniques and illustrate the sensitivity of our findings to the choice of methodology. We also provide regression evidence on the link between firm growth and productivity and draw comparisons to the 1990s recession.

We make use of the UK Annual Respondents Database (ARD), assessing labour productivity growth for the period 2007-2013 and comparing this to labour productivity growth in the pre-recession years 1998-2007. We also consider a measure of total factor productivity. We find that the majority of labour productivity weakness since the crisis occurred within firms and was associated with declines in measured total factor productivity growth relative to trend. After an initial sharp drop productivity growth within firms rebounded somewhat, but this was not sufficient to bring productivity back to pre-crisis levels. This within firm productivity weakness was pervasive across groups of firms which differ in their bank

[2] A number of studies have highlighted the sensitivity of investment by UK firms to the availability of finance (see Bond & Meghir, 1994, and Bond *et al.*, 2003). Bond *et al.* (2003) finds UK firms' investment decisions are more sensitive to cashflow than their European counterparts in Belgium, France & Germany.

[3] Arrowsmith *et al.* (2013) find some evidence to suggest that UK banks engaged in forbearance of bad debtors.

dependence and across small and large firms and main industry sectors. On the face of it these findings do not suggest that credit constraints and bank forbearance, by reducing the contribution of external restructuring to labour productivity growth, were the main factor in explaining the weakness of aggregate UK labour productivity.[4]

Even so, our analysis suggests that the contributions of composition effects to UK productivity growth did diminish following the credit crisis, particularly after the first recession years had passed. During the initial downturn in 2008-9 the positive correlation between employment growth and firms' relative productivity position was weakened among surviving firms, particularly in sectors that had a lot of small and bank dependent firms before the credit crisis. This is consistent with the idea that an adverse credit supply shock caused inefficiencies in resource allocation across firms. The effect on aggregate productivity of these changes was limited because they mainly concerned smaller firms and because of an offsetting increase in the exit rate of smaller and less productive companies, which meant that overall, in 2008-9, composition effects contributed no less to aggregate productivity growth than they did in the past. But subsequently, after the first recession years, composition effects did contribute markedly less to labour productivity growth than they had done before, consistent with impaired resource allocation. But we find no evidence to link this to sectoral bank dependence.

For manufacturing firms only we are also able to compare the 2007-2013 period to an earlier recession, which was not caused by a financial crisis. This comparison provides some suggestive evidence that the efficiency of resource allocation may have been impaired by the global credit crisis, but again, the aggregate productivity effects of this decline in efficiency are not obviously very significant when compared to the overall decline in UK manufacturing productivity growth.

Our overall conclusion is that there is some evidence that supports the idea that inefficiencies in resource allocation contributed to the stagnation in UK productivity growth 2008-2013. These inefficiencies may initially have been associated with the contraction of credit supply, but the evidence is not clear as to why these effects persisted. More importantly, we conclude that other common factors, which we do not explore in this article, for example general demand weakness coupled with flexible wages, are likely to have been central in explaining the stagnation in UK productivity growth.

[4] Bank of England research carried out independently of this study (see Barnett *et al.*, 2014b) decomposes annual UK labour productivity growth during the Great Recession using the adaptation of the Griliches & Regev (1995) decomposition described in Baily, Bartelsman & Haltiwanger (2001). They suggest that less efficient reallocation and a slowdown in creative destruction during the Great Recession accounts for a 2 percentage point fall in average annual productivity growth between 2002-7 and 2008-11.

The next section discusses why banking crises might affect resource allocation. Section 3 outlines the methodology for the analysis. Section 4 describes the data and basic trends. Results are discussed in section 5 and section 6 concludes.

2 BANKING CRISES AND RESOURCE ALLOCATION

There are good reasons to think that the impact of a banking crisis on economic performance is exacerbated by impaired resource allocation in the economy. A large empirical literature suggests financial market conditions have implications for firms' investment in R&D and fixed capital (see survey in Bond and Van Reenen, 2007). In particular, if there are capital market imperfections then the availability of finance (internal or external) becomes an important determinant of a firm's investment. In a banking crisis the availability of finance becomes constrained for bank dependent firms (typically smaller and younger companies), leading to a misallocation of finance and hence investment across businesses. Distortions to the allocation of resources across businesses may in turn reduce aggregate productivity (Bartelsman, Haltiwanger & Scarpetta, 2013). For example, by impeding the growth of high productivity but bank dependent firms, or potentially causing them to exit, and by deterring entry of start-ups that require an initial capital outlay. There may also be second order effects via reduced competitive pressure from bank dependent firms, delaying exit of low productivity companies that do not depend on bank finance, allowing them to maintain market share and to be otherwise complacent.

These ideas are formalised in the theoretical literature. Recessions are often considered to be times when the economy is rid of its less productive units (Caballero & Hammour, 1994). But, these cleansing effects may be weakened when capital markets are imperfect and firms face credit constraints, e.g. as in the case where a recession is accompanied by a banking crisis and credit crunch. Caballero & Hammour (2005) develop a model where firms' ability to finance expansion is reduced during recession, which dampens both job creation and destruction. Barlevy (2003) develops a general equilibrium model where credit market frictions can reverse the cleansing effects of recession because those businesses that require least financial resources to sustain themselves through recession are not necessarily the most productive. In both these models, credit constraints lead to a decoupling of the relationship between job creation and destruction decisions and the productivity ranking of production units. The implication is that credit constraints dampen the productivity enhancing effects of job reallocation (which may occur through firm entry, exit and changes in firms' market share).

More recently, Khan and Thomas (2013) develop a general equilibrium model with heterogeneous firms, where collateral constraints limit borrowing by young firms. These

collateral constraints cause inefficiencies in the allocation of capital across firms. Labour productivity of young firms is suppressed, because they cannot finance the capital that they require out of profits alone and they have not built up sufficient capital to post as collateral. A tightening of collateral constraints (credit supply) in this model leads to an inefficient allocation of capital, reducing aggregate capital investment and labour productivity. Young firms become slower to outgrow financial frictions and to reach their productive potential. Instead, larger and older firms expand to meet demand, which further increases dispersion in the marginal product of capital across businesses, illustrating the gains that could be made if capital could be redistributed from unconstrained to constrained firms.

Bank forbearance is another channel by which a financial crisis might distort resource allocation between firms, leading to the existence of so-called 'zombie' companies as troubled banks seek to avoid crystallising losses on their balance sheets. There is evidence that this type of behaviour was prevalent amongst Japanese banks during the early 1990s (Peek & Rosengren, 2005). Caballero, Hoshi & Kashyap (2008) develop a model where lender forbearance depresses job destruction, by the propping up of companies that should exit the market, and depresses job creation, as the congestion caused by zombie companies hinders the expansion of other companies. Studying Japan during the 1990s they find that job creation and destruction and productivity tended to be lower in sectors where there were a disproportionate number of zombie companies. But the evidence is mixed. Using a similar approach to that in this article, Griffin and Odaki (2009) explore the importance of Japanese banks' support for inefficient firms in explaining the weakness of productivity growth in Japanese manufacturing during the 1990s. Their results do not suggest that the weakness of productivity growth was associated with an absence of downsizing and exits of less productive firms.

To summarise, the studies outlined here provide a rationale for thinking that a credit crisis would dampen aggregate productivity growth by reducing the efficiency of resource allocation across firms. In the framework that we use these inefficiencies would be captured by a reduction in the contribution to aggregate productivity of compositional effects (external restructuring of firms). They may also reduce the contribution to aggregate productivity of within-firm growth (e.g. directly for small bank dependent firms and, potentially, indirectly for less bank dependent firms that face less competition, Aghion et al., 2009). But, crucially, if resource misallocation is an important transmission mechanism between banking crises and aggregate productivity performance, then we should observe this in the reduced contribution of business restructuring to aggregate productivity change.

3 RESOURCE ALLOCATION AND AGGREGATE PRODUCTIVITY GROWTH

3.1 Productivity growth decompositions

To illustrate the separate contributions to aggregate productivity performance of business restructuring and of productivity growth within firms we use a productivity growth decomposition originally proposed by Diewert and Fox (2010) (DF). Like other dynamic decomposition methods in the literature this breaks down aggregate productivity growth into four terms: a within effect, showing the contribution to aggregate productivity growth which comes about via productivity changes within continuing (C) firms when market shares are fixed; a between effect, which shows the contribution to aggregate productivity growth from changes in market share among those same continuing firms, when productivity levels are fixed; and the contributions to aggregate productivity growth of new entrants (N) and exitors (X), respectively. It is the sum of the latter three terms (between, entry and exit components) that we refer to variously as composition effects or external restructuring and which would be depressed when a banking crisis impaired the efficiency of resource allocation.

More formally, we write aggregate labour productivity at time t (Π_t) as a weighted average of the level of labour productivity of individual firms (π_{it}):

(1) $$\Pi_t = \sum_i s_{it}\pi_{it}$$

where weights s_{it} measure firm i's market share at time t, $s_{it} \geq 0$ and $\sum_i s_{it} = 1$. We use employment shares to proxy market shares such that Π_t equals the ratio of aggregate gross value added (or output) to aggregate employment, mirroring the measurement of labour productivity based on aggregate data. For continuing firms we write firm i's share of the market of continuing firms as $s_{Cit} = \frac{s_{it}}{\sum_{i\in C} s_{it}}$, where $\sum_{i\in C} s_{Cit} = 1$. We then decompose the change in aggregate labour productivity between time t-k and time t as:

(2) $$\begin{aligned}\Delta\Pi_t = &\sum_{i\in C} \overline{s}_{Ci}\Delta\pi_{it} \\ &+ \sum_{i\in C} \Delta s_{Cit}(\overline{\pi}_i - \overline{\Pi}_C) \\ &+ \sum_{i\in N} s_{it}(\pi_{it} - \Pi_{Ct}) \\ &- \sum_{i\in X} s_{i,t-k}(\pi_{i,t-k} - \Pi_{C,t-k}) \qquad \text{(DF)}\end{aligned}$$

where a bar above a variable denotes an average across time t and time t-k, and where $\Pi_{Ct} = \sum_{i\in C} s_{Cit}\pi_{it}$ is simply the share weighted average of labour productivity for continuing firms only, equivalent to aggregate labour productivity for this subset of firms. In (2) the first sum is the within component and the second sum the between component, which is positive if more productive firms gain market share and less productive firms lose market share. The penultimate and last sums in (2) measure the productivity contributions from entry and exit

respectively. The contribution to aggregate productivity growth of entrants is positive if their productivity exceeds the average productivity of incumbents, while the contribution of exitors is positive if their productivity is less than the average productivity of survivors.

We use equation (2) to assess how the importance of composition effects for productivity growth has changed since the financial crisis. There are a number of alternative dynamic decomposition methods available in the literature that we might use. A key benefit of the DF decomposition in comparison to the widely used decompositions methods of Foster, Haltiwanger & Krizan (2001) (FHK) and Griliches & Regev (1995) (GR) is that it avoids exaggerating the aggregate productivity contribution of net entry in an economy where productivity is rising. This bias arises in the FHK and GR decompositions because the productivity of entrants at time *t* is benchmarked against average productivity measured at an earlier point in time (and in GR the productivity of exitors is benchmarked against average productivity measured at a later point in time). Conversely, and for the same reason, in an economy where productivity is generally falling, the FHK and GR decompositions will tend to understate the contribution of net entry. This is important in our context because it implies that the FHK and GR decompositions will attribute too much of the slowdown in aggregate productivity growth during times of recession and stagnation to a drop in the efficiency of resource allocation between new and existing firms. Both the DF decomposition and the decomposition proposed by Melitz & Polanec (2015) (MP) eliminate this bias by benchmarking the productivity of entering (and exiting) firms on the productivity of continuing firms at the time of entry (or exit). Indeed the entry and exit contributions are identical in DF and MP; they differ in the way they split the contribution of continuing firms into within firm and external composition effects. We use the DF decomposition, which, like the GR and FHK decompositions, measures the within component using a share weighted mean.[5] We report our main results using our preferred decomposition in equation (2), but illustrate the sensitivity of our findings to different methods.[6]

[5] MP split the contribution of continuing firms into a within and a between effect using the decomposition of Olley & Pakes (1996) at time *t* and time *t-k*. Thus the within component in MP reflects the change in the unweighted mean of productivity for continuing firms. By using the unweighted mean the MP decomposition places more weight on small firms in calculating the within component than does the DF decomposition. As a result, we find that MP based estimates of both the within and between components for continuing firms are more volatile across time periods and data samples than the DF based estimates, at least when estimated on the British survey data, which is dominated by heterogeneous small firms with relatively high grossing weights due to the nature of sampling. Further, the application of the dynamic Olley-Pakes decomposition to continuing firms in MP results in a disjuncture between the measurement of the contribution of external restructuring at the intensive (between existing firms) and extensive (due to entry and exit) margins. Intuitively, the DF decomposition is more appealing in this respect.

[6] Equations for the MP, GR and FHK decompositions can be found in Appendix B. The FHK decomposition includes an additional term (the "cross" firm component), which captures the covariance between changes in market shares and changes in productivity amongst continuing firms. Following Disney *et al.*

3.2 Firm growth and productivity levels

We also investigate changes in the efficiency of resource allocation by analysing the relationship between firm growth and relative productivity in a regression framework. This is useful in gauging the statistical significance of changes in the contributions of resource allocation to aggregate productivity uncovered using the decomposition in equation (2) and allows us to examine whether changes in these contributions are related to credit supply. We assess whether the relationship between firm growth, y_{it}, and relative productivity, LP_{it}, changed after the financial crisis estimating equation (3), where D_p is an indicator variable equal to one post 2007; in practice we also use indicator variables for different stages of the post-crisis period.

$$y_{it} = \gamma LP_{it} + \gamma_p D_p \, LP_{it} + \, \delta_T + \, \delta_{IND} + \varepsilon_{it} \tag{3}$$

In equation (3) the coefficient γ is positive if higher labour productivity firms grow faster than lower labour productivity firms. The coefficient γ_p measures the change in this correlation after the financial crisis. If $\gamma_p < 0$ then the efficiency of resource allocation deteriorated after the crisis relative to the pre-crisis period. We include industry and year fixed effects. The year fixed effects pick up cyclical changes in firm growth unrelated to productivity levels.

We are interested to know whether changes in the efficiency of resource allocation after the crisis are related to a restriction of credit. In equation (4) we interact a measure of sector level bank dependence, BD, measured before the crisis, with the relative labour productivity terms. Here $\gamma_{BD} > 0$ if the correlation between productivity levels and firm growth is more positive in more bank dependent sectors. The coefficient γ_{BDp} measures the change in this relationship after the crisis. If $\gamma_{BDp} < 0$ then the efficiency of resource allocation deteriorated in more bank dependent sectors relative to less bank dependent sectors after the crisis and we interpret this as evidence of a distortion to resource allocation associated with a reduction in credit supply.

$$y_{it} = \gamma LP_{it} + \gamma_p D_p \, LP_{it} + \gamma_{BD} BD \, LP_{it} + \gamma_{BDp} D_p BD \, LP_{it} + \, \delta_T + \, \delta_{IND} + \varepsilon_{it} \tag{4}$$

The evidence we present is not causal. We do not know what other factors might cause the relationship between firm growth and their productivity ranking to change over the cycle in different sectors, unrelated to the tightness of credit. Ideally we would like to benchmark changes in resource allocation since the crisis against changes in resource allocation in a

(2003) and Harris & Moffat (2013) we interpret this term too as restructuring that is external to the firm, i.e. due to market activity rather than due to productivity changes internal to the firm.

previous recession, unrelated to a financial crisis. This would allow us to better disentangle the distinct influences of a banking crisis and a contraction in credit supply from ordinary cyclical changes in resource allocation. For firms in the manufacturing sector we do have data going back to earlier recessions. This allows us to estimate equation (5), where D_p is now an indicator variable equal to one post recession and D_{00} is an indicator variable equal to one during the 2000s. In this framework γ measures the relationship between firm growth and productivity, γ_p measures the change in this relationship during a normal recession and γ_{00} measures secular changes. The coefficient γ_{00p} then captures the change in the relationship between firm growth and productivity since the financial crisis net of normal cyclical changes and secular trends.

$$y_{it} = \gamma LP_{it} + \gamma_p D_p\, LP_{it} + \gamma_{00} D_{00} LP_{it} + \gamma_{00p} D_p D_{00}\, LP_{it} + \delta_T + \delta_{IND} + \varepsilon_{it} \quad (5)$$

Equation (5) has some similarities to the analysis in Foster, Grim & Haltiwanger (2014). Analysing the positive relationship between firm growth and TFP levels in US manufacturing since the 1970s they find this is usually counter-cyclical (in equation (5) this would imply that $\gamma_p > 0$); the tendency for the most productive firms to grow faster than other firms is stronger when unemployment is rising. They find that this was not the case after the financial crisis (in equation (5) this would imply that $\gamma_{00p} < 0$), suggesting that the efficiency of resource allocation during the Great Recession was less than might have been expected on the basis of the historical evidence.

For the continuer sample we estimate equations (3)-(5) using two measures of firm growth. First, the percentage change in employment (as in Foster, Grim & Haltiwanger, 2014). Second, the change in continuer share, Δs_{Cit}. LP is set to $\left(\overline{\pi}_i - \overline{\Pi}_C\right)$, which, when the left hand side is the change in the continuer share, provides a direct counterpart to the between effect in the DF decomposition in equation (2).[7] We also investigate the relationship between the probability of exit and relative productivity and between the probability that a firm is an entrant

[7] The firm-level productivity measure used in the decomposition literature is more often than not a log than a levels measure. We use a levels measure of productivity for two reasons. First, gross value added may be zero or negative for some firms even after a reasonable transformation and the characteristics of such firms change during recession. We want to include these firms. Second, the levels measures of firms' productivity map directly onto aggregate productivity, providing a straightforward link between productivity changes at the firm and economy levels (see e.g. discussions in MP and in Petrin & Levinsohn, 2012). Following Baily, Bartelsman & Haltiwanger (2001) we convert the productivity growth decompositions into percentage changes by dividing all terms in equation (2) by aggregate productivity at time *t-k*. For robustness we also assess productivity dynamics when firms' productivity is measured in logs. These results are qualitatively similar to those reported in this paper and do not alter our main conclusions. As in FHK we use equation (2) to decompose productivity in different industry sectors (we consider 31 sectors). We then weight these up to the aggregate level using employment shares. In estimating equations (3) - (5) the LP terms are also divided by aggregate productivity at time *t-k* and measure firm productivity relative to the industry average.

and relative productivity in a simple linear probability model. When we evaluate exit LP= $(\pi_{i,t-k} - \Pi_{C,t-k})$ and when we evaluate entry LP= $(\pi_{it} - \Pi_{Ct})$. Equations (3) - (5) then capture changes in productivity differentials between entrants and exitors versus continuing firms. Standard errors are clustered at the level of the sector and pre-post crisis periods to avoid inflated t-statistics.

4 DATA AND DESCRIPTIVES

4.1 The ARD dataset

The Annual Respondents Database (ARD) is an establishment level business survey (or set of surveys) conducted by the UK Office for National Statistics (ONS) that is widely used both in the construction of various national income and product account aggregates for the UK and in the study of firm behaviour and productivity analysis (see e.g. Harris & Robinson, 2002; Aghion *et al.*, 2009; Bloom, Sadun and Van Reenen, 2012). It holds information on the nature of production in British businesses and is essentially a census of larger businesses and a stratified (by industry, region and employment size) random sample of businesses with less than 250 employees (SMEs). It covers businesses in the non-financial non-farm market sectors.[8] Data are available for 1997-2013 and for manufacturing back to 1974 and are collected for establishments (or rather, reporting units).[9] Details of the ARD data can be found in Bovill (2012), Griffith (1999) and Harris (2005a).

The sampling frame for the ARD is the Inter-Departmental Business Register (IDBR), a list of all UK incorporated businesses and other businesses registered for tax purposes (employee or sales taxes). This includes basic information (e.g. industry, ownership structure, and indicative employment[10]) for all businesses in the sampling frame. In the sectors that we consider this population includes more than 1.5 million establishments covering employment of around 16 million people, (Appendix Table A1). The population data in the IDBR allow us to determine business entry and exit, which cannot be calculated from surveyed businesses alone (Disney *et al.*, 2003) and, importantly, allows us to calculate grossing weights so that our

[8] The ARD includes partial coverage of the agricultural sector (we exclude these businesses) as well as businesses in "non-market" service sectors such as education, health and social work. We exclude businesses in these latter sectors where inputs and outputs are thought not to be directly comparable, making productivity analysis difficult to undertake. We also exclude businesses in the mining and quarrying, and utilities sectors (typically very large businesses with erratic patterns of output) and in the real estate sector, where output mostly reflects imputed housing rents.

[9] We carry out the analysis at the level of the establishment, e.g. as in Disney *et al.* (2003) and Barnett *et al.* (2014), which we refer to as the firm or the business throughout.

[10] Indicative employment information is collected from a variety of sources and is sometimes imputed from turnover. We use this indicative measure of employment as our measure of employment for non-surveyed as well as for surveyed businesses as we do not have a consistent series of year average or point in time employment estimates for surveyed businesses.

decomposition analysis is representative of the macroeconomic phenomena that we seek to explain in terms of firms' behaviour.

In grossing up the data we take into account key aspects of the underlying stratification of the annual sample.[11] Dynamic decompositions rely on firm level data at two points in time (times *t-k* and *t*). Combining these two time periods we identify three categories of firms: those that exist throughout the period (continuers or survivors), those that exist at time *t-k* but not at time *t* (exitors) and those that exist at time *t*, but not at time *t-k* (entrants). In carrying out the decompositions we weight up the data separately for each of these three categories of firm.[12] Primarily this is because the probability of being sampled at both time *t-k* and time *t* is much smaller than the probability of being observed in either one of these time periods, and hence grossing factors need to be larger for continuers than for the other categories of firm within the same sample stratification cell. This is important because surviving firms tend to have different productivity levels to entrants and exitors. It also allows us to easily replicate population market shares (the s_i in the productivity decompositions, which are known) and write simple grossed versions of the dynamic decompositions we consider.[13]

We measure labour productivity as GVA per head. Our main focus is on labour productivity, but we also use information on firms' investment expenditures to construct capital stock[14] and TFP[15] measures. The ARD financial information is published in current values. GVA deflators published by the ONS are used to construct real values; these are available at the 2- and sometimes the 3-digit sector level.[16]

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[11] We follow the advice in ONS (2002) and use the ratio of population to survey aggregates (e.g. number of firms or employment) within sampling strata as grossing weights. Sampling strata are defined in terms of industry, employment size groups and region. We ignore regions due to small cell sizes. Extreme grossing weights due to small cell sizes are eliminated by further aggregation.

[12] For continuing firms we average start and end period weights to ensure that productivity and market share changes for these firms do not reflect changes in grossing weights.

[13] In the longitudinal ARD data sampling probabilities are very small for businesses employing less than 10 employees (see Appendix Table A2). For this reason and because employment tends to be less accurately measured for this group of firms we have also carried out the dynamic decompositions excluding micro firms. This does not change the conclusions that we draw from the analysis.

[14] We construct firm level measures of machinery & equipment capital stocks and building & structure capital stocks using information on investment net of disposals of these assets available in the ARD. Investments are deflated by investment deflators by asset and industry obtained from EUKLEMS/ONS. Firm-level capital stocks are then calculated using the perpetual inventory method and EUKLEMS depreciation rates. Starting stocks are informed by industry capital stocks that can be derived by a similar method using EUKLEMS/ONS investment data. Although not shown in this paper, we have as a sensitivity test also used plant & machinery capital stock data aggregated from plant level capital stock data to 2012 provided by Richard Harris. The methodology underlying their construction is described in Harris (2005b). We reach similar conclusions in this paper using either capital stock series.

[15] We derive a simple measure of TFP using the formula $TFP_i = Y_i / (K_i^{(1-\alpha L)} L_i^{\alpha L})$, where α_L is the industry average labour share on average over the relevant time period. Y is GVA, K is the estimated capital stock and L is labour.

[16] Before 2008 industry was coded to the UK Standard Industrial Classification 2003. From 2008 onwards this changed to the UK Standard Industrial Classification 2007. To maintain broad continuity in the sectors that we analyse this requires us to drop a few 3-digit sectors.

4.2 Trends in productivity and business churn

We study productivity changes in the aftermath of the global financial crisis that started in 2007. UK GDP shrank in 2008 and 2009. During this recession labour productivity fell, so that by 2009 whole economy labour productivity was 4% below its peak in 2007.[17] This is a typical cyclical response, but four years later in 2013 labour productivity on this measure was still 1% below its 2007 peak, and 14% below its pre-crisis trend. It is this stagnation of productivity in 2010-13 that is of particular interest as it raises the question whether the supply capacity of the economy was harmed by financial factors that caused a misallocation of resources.

Figure 3 shows the development of labour productivity over this period in the market sectors that we look at. We show three separate series. One is based on the grossing up of the ARD microdata used in the decomposition analysis and is shown alongside a productivity profile that can be generated from sector data published by the ONS based on the same business surveys (ABI & ABS series in Figure 3). Both of these series illustrate a stagnation in market sector labour productivity in the aftermath of the credit crisis, with productivity levels in 2013 remaining around 2007 levels, much as for the whole economy. Figure 3 also shows a labour productivity series for the entire market sector, published by the ONS, which suggests that relative to 2007 labour productivity in 2013 was weaker still, largely reflecting falling productivity in the North Sea oil extraction industry.

As shown in Figure 3 the labour productivity profile that is based on our decomposition sample differs slightly from the series based on published data. Such differences are well-known (Franklin & Murphy, 2014) and arise because of small differences in sector and size coverage and, inevitably, our cleaning and weighting procedures differ from those undertaken by the ONS.[18] The series constructed from our decomposition sample displays a steeper fall and recovery in labour productivity between 2007 and 2010 than the two series based on official statistics, although the difference to the ABI&ABS series is less. All three series exhibit broadly the same pattern over time, with market sector labour productivity 6 years after the financial crisis remaining close to or a little below its 2007 peak and 14-18 per cent below a simple linear extrapolation of the trend since 1998 that preceded the crisis.[19]

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[17] ONS series LNNN "Output per filled job: Whole economy", where output refers to gross value added.

[18] We truncate the top and bottom 1% of the labour productivity distribution within 31 industry sectors in each annual survey. In the decomposition sample, which is much smaller than the ARD cross sectional sample because it excludes false entrants and exits (i.e. firms classified as continuers in the population files, but which only appear in the sample at either the start period, *t-k*, or the end period, *t*), we eliminate further outlying observations in order that the grossed sample reflects broadly the same productivity trends apparent in the full sample and other sources. Specifically, we truncate the top and bottom 2.5% of annual changes in labour productivity by industry sector and year.

[19] The labour productivity indices in Figure 3 illustrate trends in GVA per worker. The decline in average hours worked in the years following the financial crisis does not change much the overall picture of productivity stagnation. For example, the market sector productivity gap based on the ONS output per

Business failures were relatively muted post-2007 despite the scale of the recession. And it is the absence of a more substantial increase in business deaths, seen against the backdrop of a fall in GDP of 6%, that led to concerns that bank forbearance may have propped up businesses that would otherwise have died (Arrowsmith *et al.*, 2013). Annual business entry and exit rates 1998-2013 for the population of firms we consider are shown in Figure 4.[20] Consistent with data published elsewhere (see *Business Demography, 2013*, ONS Statistical Bulletin (2014)) we observe a dip in annual entry rates in 2009 and 2010 of around 2 percentage points and a rise in the annual exit rate in 2008, reflecting an increase in the share of firms that ceased to exist in 2009 as the recession took its toll. Prior to the recession entry rates were higher than exit rates and the business population was expanding. After the financial crisis business entry rates declined as it became more difficult or less worthwhile to enter the market and were similar to corresponding exit rates (until 2013), which increased only marginally.

How business churn affects productivity depends on the relative productivity performance of businesses that enter and leave the market and of surviving firms. Labour productivity for these groups of firms is shown in Figure 5. Typically it is lower productivity firms that exit. Labour productivity amongst entrants is on average low relative to incumbents, possibly reflecting that entrants are less capital intensive and have the scope to grow, but the gap between these two groups is less than the gap between dying and surviving companies, so that net entry (entry less exit) boosts productivity, as is typically found in the literature.

Figure 5 also illustrates that the gap in labour productivity between incumbent firms and entrants and between surviving firms and dying firms widened after the global financial crisis. The drop in the relative "quality" of entrants is consistent with a situation where a lack of credit has made it increasingly difficult for capital-intensive businesses to enter the market and will tend to reduce the contribution of entry to aggregate productivity growth. The opposite would occur if banks became more selective in financing entrants or if tough market conditions meant entry was feasible only for the most productive firms. There is some evidence of this in 2008, when entrants were broadly as productive as incumbents. The productivity gap between continuers and exitors might be affected by bank forbearance. The direct effect of bank forbearance on the "quality" of exitors relative to those that survive could be positive or negative, depending on the relative productivity of firms that are kept alive due to forbearance and those that exit. If, amongst firms that would normally exit, bank forbearance is offered to the most productive firms, then it is more likely that the quality of exitors will decrease relative

hour worked series (GYY7) is near identical to the gap based on the ONS output per worker series (GYY4) shown in Figure 3.

[20] Ownership changes may also be recorded as entry and exit in these data because this can lead to changes in establishment identifiers (the same applies to enterprise identifiers).

to survivors, consistent with what we observe in the initial years following the crisis and which will tend to increase the contribution of exit to aggregate productivity growth.

5 PRODUCTIVITY DYNAMICS IN THE WAKE OF FINANCIAL CRISIS

5.1 Evidence from productivity growth decompositions

The effects on aggregate labour productivity growth of external restructuring, through changes in market shares or business entry and exit, can be assessed using the productivity growth decomposition described in equation (2) above. Table 1 shows these contributions to the change in aggregate productivity between 2007 and different points in time after the crisis up to 2013. Table 1 also shows these contributions for the pre-crisis period 1998-2007 for different time horizons (1, 3, 4, 5 and 6 years changes; 2 years changes cannot be assessed with the longitudinal data we use), providing a benchmark against which to assess post-crisis growth.

In the first year of the recession labour productivity fell by 5%. This was the result of a reduction in productivity within firms of 7.4% offset by a positive contribution from external restructuring of 2.4%. Looking at cumulative productivity change between 2007 and 2013 suggests that productivity in 2013 was 2.2% above 2007 levels, the result of a fall in productivity within firms of 2.5% and a positive contribution from external restructuring of 4.7%. Thus, aggregate productivity since 2007 would have been even lower than it turned out to be had it not been for the positive contributions of changes in resource allocation between firms. But it is difficult to draw conclusions from this, because we do not know what the counterfactual contribution from reallocation would have been in the absence of a financial crisis. We can say something about this by comparing the contributions to aggregate productivity change after the financial crisis with those before. The *difference* between post crisis growth and average productivity growth before the crisis shown in Table 1 provides a measure of the productivity shortfall after the crisis relative to trend. This suggests that the reduction in aggregate labour productivity relative to trend, during the acute phase of the crisis when output was falling, was accounted for entirely by a drop in productivity within firms.

It is significant that the contribution of different sources of productivity weakness appear to change over time. In particular the importance of subdued external restructuring becomes more prominent beyond the first two years of the recession. Within firm productivity weakness remained a substantial drag on aggregate productivity relative to trend up to the end of the period we analyse. In 2013, 7.8%-points of the 12.2% gap between productivity measured relative to its pre-crisis trend was accounted for by a fall in productivity within firms. But, over time the contributions of external restructuring to aggregate productivity growth appear progressively weaker than they did before the crisis. Between 2007 and 2011 external

restructuring added 4.3% to aggregate productivity. This is not very different from the period before the crisis when, evaluated over a 4-year time span, external restructuring added on average 5.8% to aggregate productivity. However, between 2007 and 2013 external restructuring added 4.4% less to aggregate productivity than it did over a similar time span in the pre-crisis years (4.7% instead of 9.2%). This difference is more substantial and suggests that around a third of the productivity shortfall by 2013 was associated with a reduction in the productivity contributions of external restructuring.

The extent to which the productivity gap can be accounted for by within firm weakness versus reduced contributions from external restructuring varies across decomposition methods. In Table 2 we show the difference in the contributions of within firm changes and external restructuring to aggregate productivity growth after the crisis compared to the pre-crisis period using different decomposition methods. We also show the share of the total productivity gap that is accounted for by changes in the contributions of external restructuring. Up to 2010 all decompositions suggest a relatively small role for any weakness in productivity coming from deficiencies in resource allocation. But when we assess productivity weakness to 2012 and 2013 all decompositions suggest that the contributions of external restructuring were materially weaker than before the crisis, accounting for at least some of the productivity gap relative to trend. But, from 2011 both the FHK and GR decompositions suggest a much larger contribution to the productivity gap from the decline in the contribution of external restructuring than the DF or MP decompositions. This is primarily for the reasons discussed in section 3; the FHK and GR measures of the contribution of net entry fall when average productivity growth falls for reasons unrelated to the efficiency of resource allocation. Therefore, the FHK and GR estimates in Table 2 undoubtedly exaggerate the importance of inefficiencies in resource allocation for aggregate productivity weakness. Despite this, all decomposition methods point to the importance of understanding within firm reductions in productivity growth when seeking to explain the general weakness of UK labour productivity in the wake of the financial crisis.

A decomposition of labour productivity changes into contributions from within firm changes and external restructuring at an annual frequency yields additional insights and a robustness check on the numbers in Tables 1 and 2. Figure 6 illustrates that the sharp fall in productivity growth (and in productivity levels) during the recession was associated with a reduction in productivity growth within firms. While the within contribution bounced back after the recession, it failed to rebound sufficiently to bring labour productivity back to the levels seen before the financial crisis. On average, the contribution of the within component to annual labour productivity growth fell by 1½%-points in the six years after the crisis compared to 1998-2007. Figure 6 also illustrates, much as the numbers in Table 1, that following the credit

crunch the contribution of external restructuring to labour productivity growth gradually shrunk, providing stronger evidence of inefficiencies in resource allocation that harmed aggregate supply capacity. In Figure 7 we use these annual growth decompositions to illustrate developments in the productivity shortfall 2008-2013 (the difference between productivity implied by pre-crisis growth rates and actual productivity). The within component accounts for all of the shortfall initially, but by 2013 there is a 4%-point difference between the productivity shortfall and that which can be attributed to the within component. This is the contribution to the shortfall of the external component and suggests that by 2013 this accounted for a quarter of the cumulative shortfall, with the within component accounting for three-quarters of the shortfall.[21]

Further insight can be gained by investigating the behaviour of total factor productivity (TFP), the efficiency with which capital and labour is used. Productivity growth within individual businesses can be accounted for by the contribution of growth in the capital intensity of the business (represented by the capital-labour ratio) and TFP. Because capital is costly to reduce in an economic downturn, measured TFP within firms tends to move pro-cyclically alongside movements in capacity utilisation. This is what we see in Table 3, where annual labour productivity growth before and after the crisis is decomposed into contributions from TFP and capital deepening.[22] The drop in annual growth after the crisis of 2.9%-points is largely explained by a reduction in measured TFP growth[23] (2.6%-points), which mainly occurs within firms (2.2%-points). Thus the weakness of labour productivity after the financial crisis appears to be associated with an issue of efficiency within establishments rather than one related to a misallocation of resources between businesses. The reduction in the contribution of external restructuring to aggregate labour productivity growth after the crisis is associated with both the allocation of capital and TFP.

[21] Note that the MP decomposition suggests the fall in the contributions of external restructuring to annual labour productivity growth is less than implied in Figures 6-7 derived using the DF decomposition. This is consistent with the numbers in Table 2. Both the GR and FHK decompositions of annual labour productivity growth 2008-2013 point to a much smaller role for inefficiencies in resource allocation than the GR and FHK decompositions over longer time spans in Table 2. This is for the reasons discussed in Section 3.

[22] This is a different sample to that used in the rest of the paper. In particular, the data is truncated on both the distributions of labour and total factor productivity and we consider only firms with 10 or more employees. The split between capital deepening and TFP contributions is not dissimilar to that shown in *Multi-Factor Productivity, Indicative Estimates to 2012*, ONS (2014).

[23] Pessoa & Van Reenen (2014) suggest that a combination of the increased cost of finance for some companies and increasingly flexible wages in the UK (Gregg & Machin, 2014) may have led firms to substitute labour for capital resulting in weaker labour productivity growth. Oulton (2013) argues that the estimate of capital per worker used by Pessoa and van Reenen is incorrect as it is based on too high an estimate of the pre-crisis capital stock. Field and Franklin (2014) suggest that by far the majority of UK labour productivity weakness is explained by a reduction in TFP rather than a reduction in the capital-labour ratio, consistent with the estimates in this paper. These explanations are not necessarily at odds. It is possible that measured TFP captures an element of capital under-utilisation and a reduction in unmeasured capital assets.

5.2 Analysis for groups of firms

The significant fall in the contribution to aggregate labour productivity growth of within firm productivity growth is pervasive across main industry groups and is evident for both small and large firms. This points to a relatively broad based (across key groups of firm) shock to labour productivity within firms as a key driver of productivity weakness, rather than inefficiencies in resource allocation or within firm weakness related to banking sector distress.

In Table 4 we split the DF decomposition of aggregate annual labour productivity growth (that underlies Figures 6 and 7) into that which can be attributed to SMEs and that which can be attributed to larger firms (with more than 250 employees). The distinction between SMEs and larger firms is important because larger firms can typically access alternative forms of finance to bank finance and SMEs are less able to do this. For both SMEs and larger firms the within component accounts for the majority of the labour productivity gap six years after the crisis. The reduction in the contribution of external restructuring to productivity growth is mostly accounted for by larger firms, which typically are not bank dependent. While it is difficult to draw any strong conclusions, this may suggest that any inefficiencies in resource reallocation that have arisen since the financial crisis are partly related to factors other than a lack of credit, e.g. low interest rates or general uncertainty about the economic outlook.[24]

In Table 5 we illustrate the components of labour productivity growth in different sectors.[25] There are two points of interest. First, in all sectors we find that the within firm contribution to annual labour productivity growth 2008-2009 was negative, followed by a rebound 2010-2013. But, with the exception of the construction sector, this rebound was not sufficient to make up for the loss within firms in 2008-9. Second, the extent to which the external contribution to annual labour productivity growth weakened in comparison to the pre-crisis period varies across sectors. We return to this in the next section.

5.3 Regression evidence

We also examine changes since the financial crisis in the link between firm growth and productivity levels in a regression framework. In Table 6 we report estimates of the relationship between firm growth (measured by employment growth) and firms' relative productivity position within the industry; as specified in equations (3) and (4). In the first row we estimate equation (3), assessing the change in the relationship between annual changes in firms' employment and their relative productivity position between 1999-2007 and 2008-2013. In the

[24] The quarterly Deloitte CFO survey would point to low risk appetite and elevated uncertainty as being significant factors explaining lack of external restructuring among large companies over this period.
[25] Sector growth patterns are more erratic that what we can construct for the market sector as a whole. We have also undertaken this analysis using decompositions over different time horizons. These can yield different sector growth patterns, but the conclusions we draw in the text are unaffected.

first two columns we see that amongst continuing firms, those that are more productive tend to grow faster (the coefficient on LP is positive and statistically significant). In column 3 we see that more productive firms are less likely to exit (the coefficient on LP is negative) and in column 4 we see that there is little difference in the relative productivity of entering versus continuing firms. These relationships mean that annual changes in the composition of the business population tend to add to aggregate labour productivity. Interacting LP with a dummy variable for 2008-2013 we see that the positive relationship between employment growth and relative productivity levels weakened after the crisis for continuing firms. This is consistent with the decomposition evidence we presented in previous sections. Exitors became less productive relative to continuers (adding to productivity growth) and entrants became less productive relative to continuers (subtracting from productivity growth), but neither of these changes are statistically significant.

In the second row we interact LP with two separate dummies for the different stages of the post 2007 period: the initial acute phase 2008-2009 when the economy was in recession and the period 2010-2013. Here we see a difference between the two regressions for continuing firms. When we measure firm growth as the percentage change in employment in the first column we find a statistically significant reduction in the LP coefficient in both of the post 2007 sub-periods When instead we measure firm growth as the change in the industry employment share in the second column we observe a reduction in the LP coefficient in both post-2007 sub-periods, but this reduction is statistically significant in the period 2010-13 only. The reduction in the LP coefficient during 2008-9 is likely not significant when we look at changes in employment shares rather than percentage changes in employment because affected firms are relatively small. Percentage changes in employment will lead to much smaller changes in a firm's market share if the firm is small. This interpretation is consistent with what we see in Table 4 where we split the DF decomposition of annual labour productivity growth into contributions from SMEs and larger firms. Before 2007 the between component for SMEs added on average 0.7%-points to aggregate annual labour productivity growth. This contribution fell to 0.4%-points on average 2008-9 and stayed at this level in 2010-13. Before 2007 the between component for large firms added 0.7%-points to aggregate annual labour productivity growth, much as for SMEs. This was unchanged in 2008-9, but fell to 0.3%-points on average 2010-2013. When we interact LP with two separate dummies for the different stages of the post 2007 period we also see that entrants became significantly less productive relative to continuers in the 2010-2013 period. This is also consistent with what we see in Table 4, where the contribution of entering firms to aggregate annual labour productivity growth fell sharply in the 2010-2013 period. This was due to a rise in the entry rate in combination with the reduction in entrants' relative productivity that we observe in Table 6.

In the third and fourth rows of Table 6 we estimate equation (4), where we include interactions between the terms in equation (3) with an indicator of pre-crisis sectoral bank dependence. This is calculated as the share of assets due to SMEs with bank finance in the sector on average 2005-7.[26] As shown in the third row, the positive relationship between the percentage change in employment and a firms' relative productivity ranking was stronger in more bank dependent sectors (the coefficient on the interaction between the bank dependency term and LP is positive). This is not the case for any of the other outcomes we consider. Considering the percentage change in employment regression in the first column we see that the drop in the LP coefficient 2008-13 is larger in more bank dependent sectors (negative coefficient on LP x BD x 2008-2013), but this is not statistically significant. When we look at the two separate periods of the post 2007 period in row 4 we find that the deterioration in the positive relationship between the percentage change in employment and labour productivity in 2008-9 is related to sector bank dependence. As discussed above, the fall in the LP coefficient 2008-9 in this regression is driven by small firms, and we conclude that this is associated with sectoral bank dependence.[27] When we measure firm growth as the change in the firm's share of industry employment we see that the decline in the LP coefficient 2010-2013 is unrelated to bank dependence. This is perhaps not surprising as the decline in the LP coefficient is at least in part associated with the behaviour of large firms, which are not bank dependent. We see no significant interactions between sector bank dependence and LP in the entry and exit regressions.

5.4 Recessions compared

The labour productivity decompositions presented so far suggest that if anything the stagnation that we observe at the level of the macroeconomy is also very much a phenomenon observed at the level of the firm, with most of the slowdown in productivity growth associated with a similar stagnation in productivity within firms rather than inefficiencies in the way that resources are allocated across firms. On the basis of this evidence we suggest it is difficult to argue that it was by impeding the efficiency of resource allocation that the banking crisis affected the supply side of the economy in a substantial way, although we do find some evidence to suggest this was a contributing factor to the productivity slowdown. But so far we have only compared the recession period after 2007 to periods of normal or above normal growth, making no allowance for the potential cyclicality of the magnitude of job reallocation and associated productivity

[26] Based on accounting information held by Companies House available in FAME. All incorporated businesses are required to report whether there is a charge raised against them and report their total assets. We calculate this number for 31 sectors.

[27] Note that we include firm size controls in the regression. The results here are not affected by the inclusion of interactions between firm size and LP and their interaction with time.

changes.[28] To get a better handle on what would have been the counterfactual contribution of external restructuring if the recession had not been caused by a global financial crisis and credit crunch we compare productivity dynamics in the recent recession to those during the last 'normal' UK recession, which started in 1990 and which was not triggered by a banking crisis, but by a fiscal and monetary policy tightening in response to an overheating economy. This allows us to gauge whether we should have expected the cleansing effects of recession to have provided a greater boost to productivity than we observe post-2007. The available data do not allow us to decompose market sector productivity changes for the previous recession, but we do have manufacturing data for this earlier period and can make the comparison between recessions for businesses in this sector. In both recessions, beginning in 1990 and 2008, manufacturing output fell sharply. But, in the earlier recession, labour productivity rose on average during the years that output contracted, in stark contrast to recent experience.

Table 7 shows how five-year labour productivity growth in the manufacturing sector breaks down into contributions from changes in productivity within firms and from changes in market share, entry and exit. The picture there is similar to that for the market sector as a whole, which is dominated by services in the sense that the slowdown in manufacturing productivity growth 2007-2012 arises very much because of a slowdown in productivity growth within firms.[29] The contribution to productivity growth from external restructuring over this period remains positive, but is less than in pre-crisis years and explains relatively little (23%) of the productivity shortfall relative to trend. Table 7 also shows labour productivity growth in the manufacturing sector before and after the recession of 1990. Then productivity growth in the five years after the recession was almost identical to what it was in the five years before, despite a swing in output growth from 14.4% before the recession to -3.9% afterwards. Surviving firms more than maintained the fast rate of productivity growth they had achieved prior to the recession. The contribution from external restructuring actually fell marginally.

[28] There is a large body of evidence that suggests gross job creation and destruction (the sum of jobs lost in dying or shrinking firms and jobs gained in newly born or expanding firms) is countercyclical (studies by Blanchard & Diamond (1990), Bronars (1990), Davis & Haltiwanger (1992, 1990) for US manufacturing, and Davis, Faberman & Haltiwanger (2006, 2012); Konigs (1995) finds that in UK manufacturing gross job reallocation was countercyclical during the 1970s and 1980s). More importantly, a smaller and related body of evidence looks at whether gross job reallocation, or external restructuring, is more or less productivity enhancing during recessions. The evidence is not conclusive. Looking at 5-year productivity growth decompositions in US manufacturing during the 1970s and 1980s, FHK suggest that the contributions to productivity growth of both between-establishment reallocation and net entry were larger during the period of cyclical downturn 1977-1982 (although this may partly reflect the issues raised in section 3). Using the GR decomposition, Baily, Bartelman & Haltiwanger (2001) find that the annual productivity contribution of market share reallocation between plants was counter-cyclical in US manufacturing 1973-1989.

[29] Note that we limit the sample to firms with a minimum of 20 employees to facilitate comparison with the 1980s and 1990s.

Benchmarking manufacturing productivity growth 2007-2012 against the same 1989-1994, it would appear that the weakness of manufacturing productivity in the more recent case was more than entirely due to the weakness of productivity within manufacturing firms. The 20% productivity shortfall is due to a shortfall in the within component of 24.2%-points offset by an increase in the external restructuring component of 4.4%-points. Benchmarking the productivity gap relative to trend against the same in the 1990s, we find that the external component is weaker than we might have expected (by 5.5%-points), but this does not go far in explaining the short-fall in productivity of 32.8%.

In Table 8 we also find some evidence to suggest that the relationship between employment growth and relative labour productivity weakened after the crisis relative to what might have been expected on the basis of historical evidence. The relationship between employment growth for continuing firms and relative labour productivity is positive. This relationship does not change in recession (i.e. we find no evidence of cyclical changes in the LP coefficient based on what happened in the past; the coefficient on LP x recession is not significant). There is some evidence that the relationship between employment growth and labour productivity was stronger during the 2000s than during the 1980s and early 1990s, although this trend is not statistically significant. When we measure employment growth as the change in the industry share of employment we see that the post 2007 period was different, controlling for cyclical factors and secular trends. The coefficient on LP x recession x 2000s is negative and statistically significant, albeit at the 10% level only.

These comparisons provide some evidence that following the Great Recession, the off-set to the productivity drop within firms that was provided by the external restructuring of businesses may have been more muted than expected on the basis of historical experience. However, the main conclusion that emerges from this comparison of recessions is that the recent recession was different to the previous recession because productivity growth collapsed within firms. This is unlikely to be directly related to credit restrictions which would not have prevented businesses from laying off workers. It is more likely to be associated with the lack of cost pressures, including low nominal wage growth, that allowed businesses to survive in a low-demand environment. High nominal interest rates, an overvalued exchange rate and continued wage growth in the earlier recession are likely to have incentivised surviving businesses to continue to boost productivity growth to a far greater extent than was the case in the most recent recession.

6 DISCUSSION AND CONCLUSIONS

Recovery from the global financial crisis and recession of 2007/8 has been a slow process associated with marked productivity weakness in many advanced economies. In this paper we consider whether inefficient resource allocation is likely to be a key transmission mechanism between banking sector collapse and the wider economy, contributing to supply side weakness and prolonged stagnation. We decompose UK market sector labour productivity growth during the period of the Great Recession and beyond to study underlying productivity dynamics amongst UK businesses. To discern from the data whether it is likely that the recent stagnation in productivity growth can be explained by a reduction in the efficiency of resource allocation between high and low productivity firms we decompose productivity growth into that which is accounted for by growth within firms and that which is due to composition effects. We use a decomposition method that avoids known biases in estimates of the magnitude of productivity contributions arising with the restructuring of the business population, inherent to some of the most widely used decomposition methods, at the same time being relatively robust to measurement error. We show that this is important to the conclusions one might draw from this type of analysis.

Examining data for British firms we find that the reduction in UK labour productivity between 2007 and 2013 was mainly the result of a broad-based decline in productivity within businesses rather than a reduction in allocative efficiency between existing businesses or a reduction in the contribution of firm entry and exit to aggregate productivity growth. We find that during the Great Recession and subsequent stagnation the contribution of external restructuring to aggregate productivity growth continued to be positive. However, it was smaller than it had been before the crisis and was not sufficient to offset fully the large drop in productivity within firms. The question of what caused this productivity drop within firms remains. It is more likely to be associated with the lack of cost pressures, including low nominal wage growth, allowing businesses to survive in a low-demand environment than a direct consequence of a reduction in credit supply.[30]

Nevertheless, we do find some patterns in the data that point to an empirical link between banking sector crises, resource misallocation and aggregate productivity. We find some evidence that the relationship between firm growth and relative labour productivity was weaker in the Great Recession in sectors with many small and bank dependent businesses. The

[30] Wage flexibility is likely to have been important. We find no evidence of labour hoarding. A standard dynamic labour demand function derived from a Cobb-Douglas production function or from a CES production function (which allows for a technology trend) does not suggest that firms were hiring more workers than they would normally do given the low level of wages and output. We estimate labour demand using OLS, a dynamic fixed effects estimator, and a system GMM estimator. Results available on request.

contribution of external reallocation to aggregate productivity growth was less in 2010/13 than in previous years, although not obviously associated with sectoral bank dependence. We also find that compared to the recession of 1990, which was not caused by a financial crisis, the contribution of external restructuring in the manufacturing sector since 2007 has been weaker than might have been expected.

Our analysis is largely descriptive, yet it is revealing and draws attention to key facts that different explanations of the productivity slowdown will need to account for. Specifically, although we observe in the data patterns that are suggestive of some impact from banking sector impairment on aggregate productivity via less efficient resource allocation, this does not obviously explain the main trends in the data. Rather, it appears that a significant component of the decline in productivity is pro-cyclical, associated with productivity weakness within firms and possibly reversible when output recovers on a sustainable basis. This is not to say that the banking crisis had little effect on aggregate productivity performance. First, we cannot say with certainty what the productivity contribution of external restructuring would have been in the absence of a banking sector crisis. Second, it is also possible that the banking crisis and the associated uncertainty have meant that businesses have not invested in the type of productivity enhancing activities that would normally lead to faster growth. This may partly account for the widespread lack of growth within firms as well as some weakness in external restructuring.[31] Also, credit constraints may have contributed to productivity weakness within some firms. To assess this in more depth it is necessary to understand more about the financial arrangements of different companies. In particular, whether amongst surviving companies productivity growth has been weaker amongst credit constrained companies than amongst companies with less reliance on the banking sector.

Word count: 9681

[31] For example, Crawford *et al.* (2013) find that the drop in labour productivity within UK firms that appear in the ARD at some point during 1997-2007 and during 2008-2009 was associated with reduced investment.

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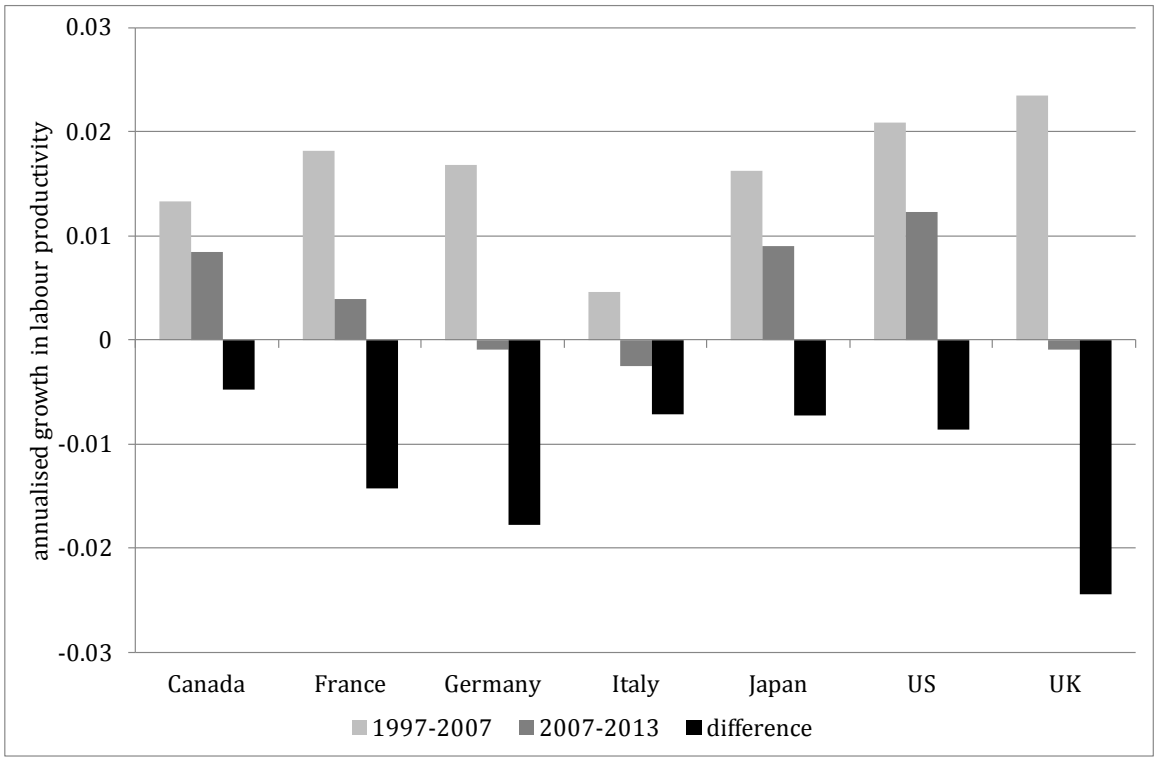
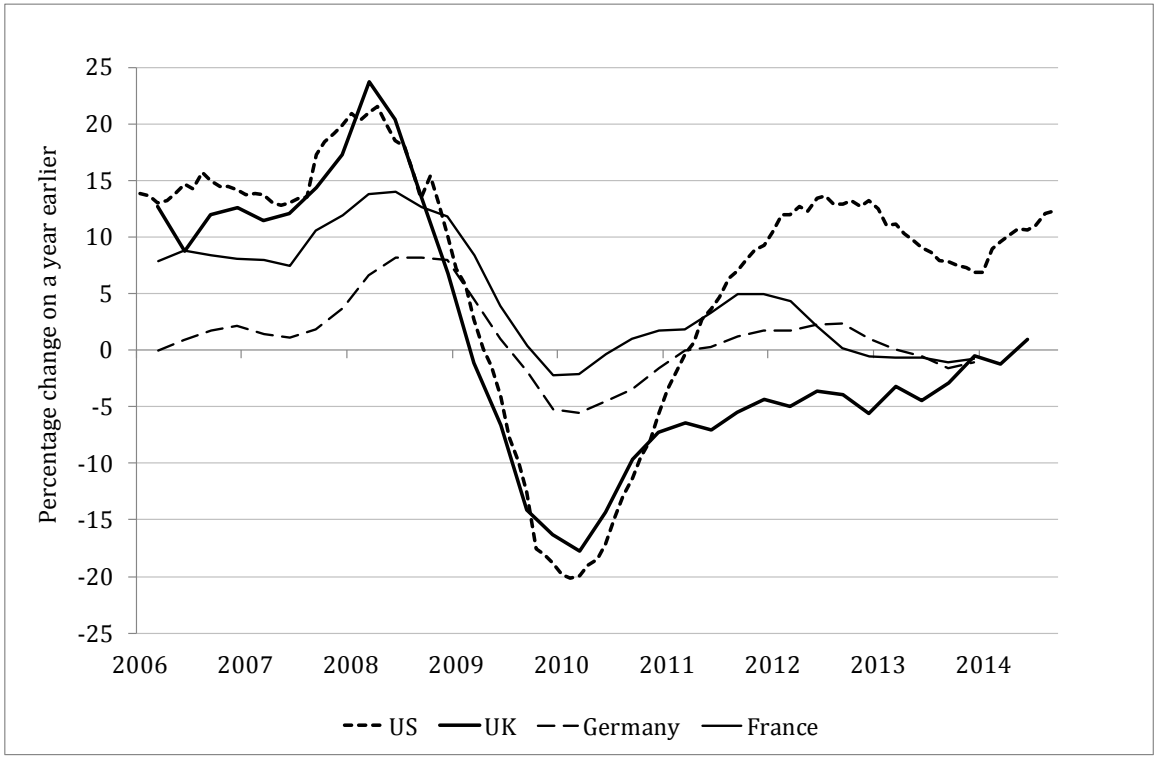
FIGURES & TABLES

FIGURE 1 LABOUR PRODUCTIVITY GROWTH IN THE G7, 1997-2013



Source: Table 3 Constant price GDP per hour worked, in *International Comparisons of Productivity, Final Estimates for 2013*, ONS Statistical Bulletin, 20 February (2015).

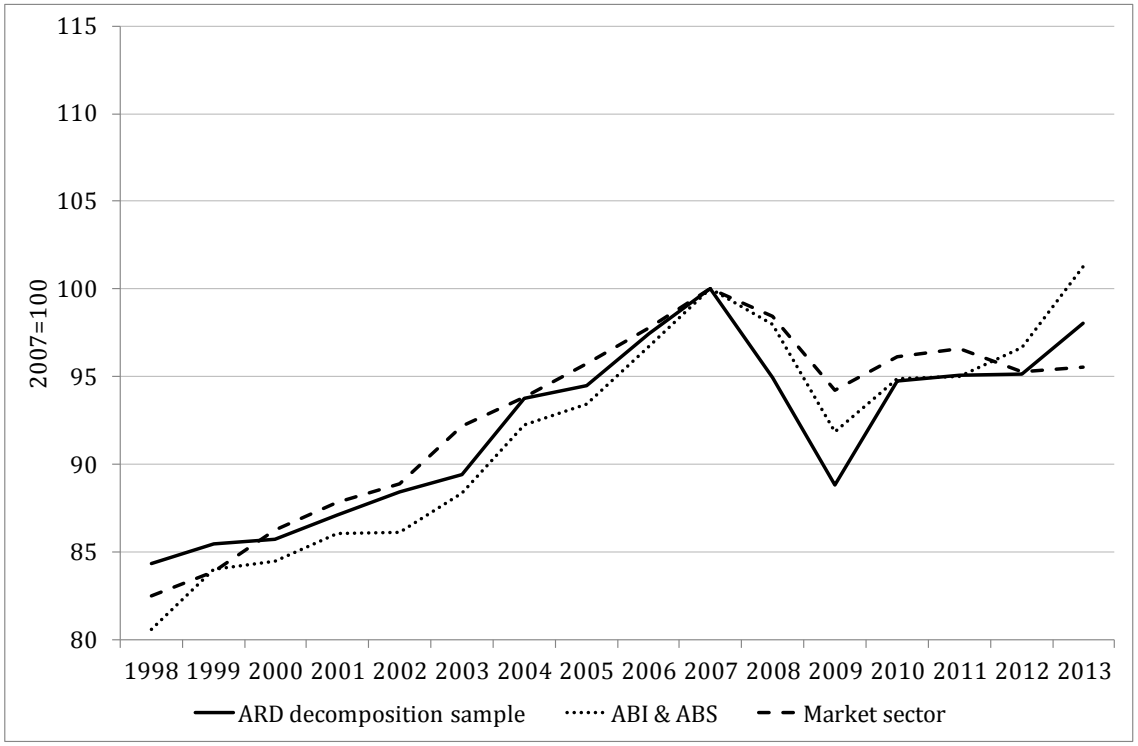
FIGURE 2 BANK LENDING TO PNFCs



Source: Bank of England.

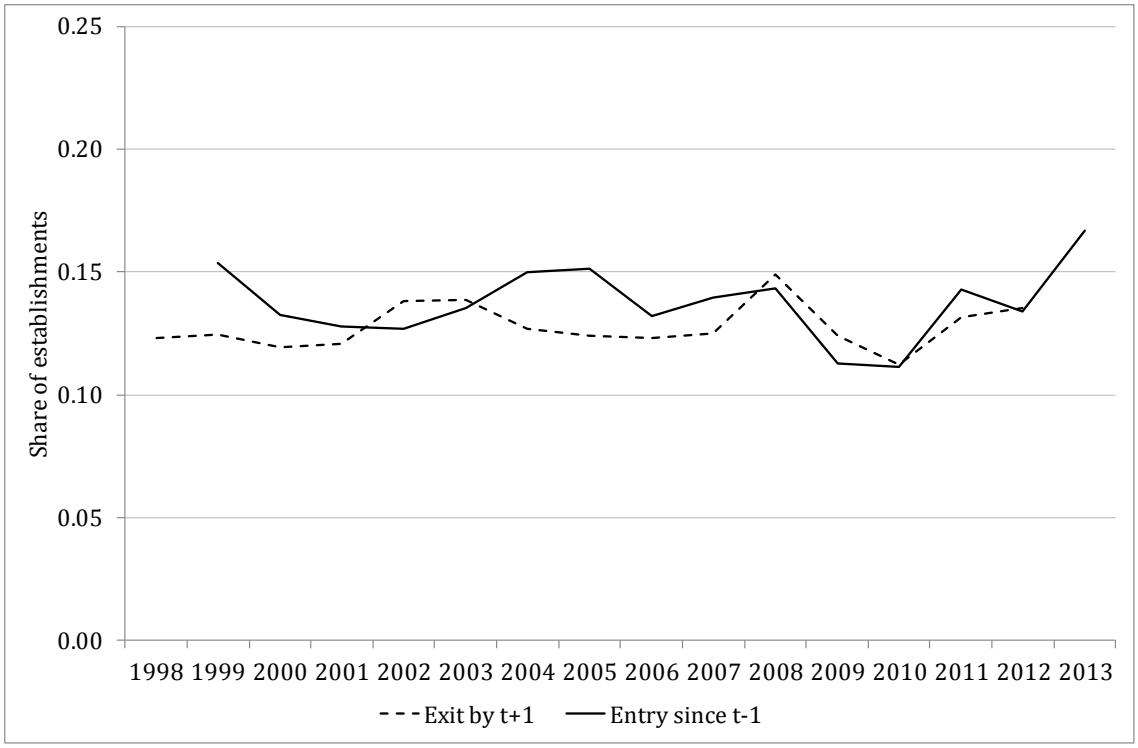
Notes: Bank lending to private non-financial corporations. UK and US data exclude commercial real estate loans. Germany and France data exclude loans to the construction sector.

FIGURE 3 TRENDS IN UK MARKET SECTOR LABOUR PRODUCTIVITY, 1998-2013



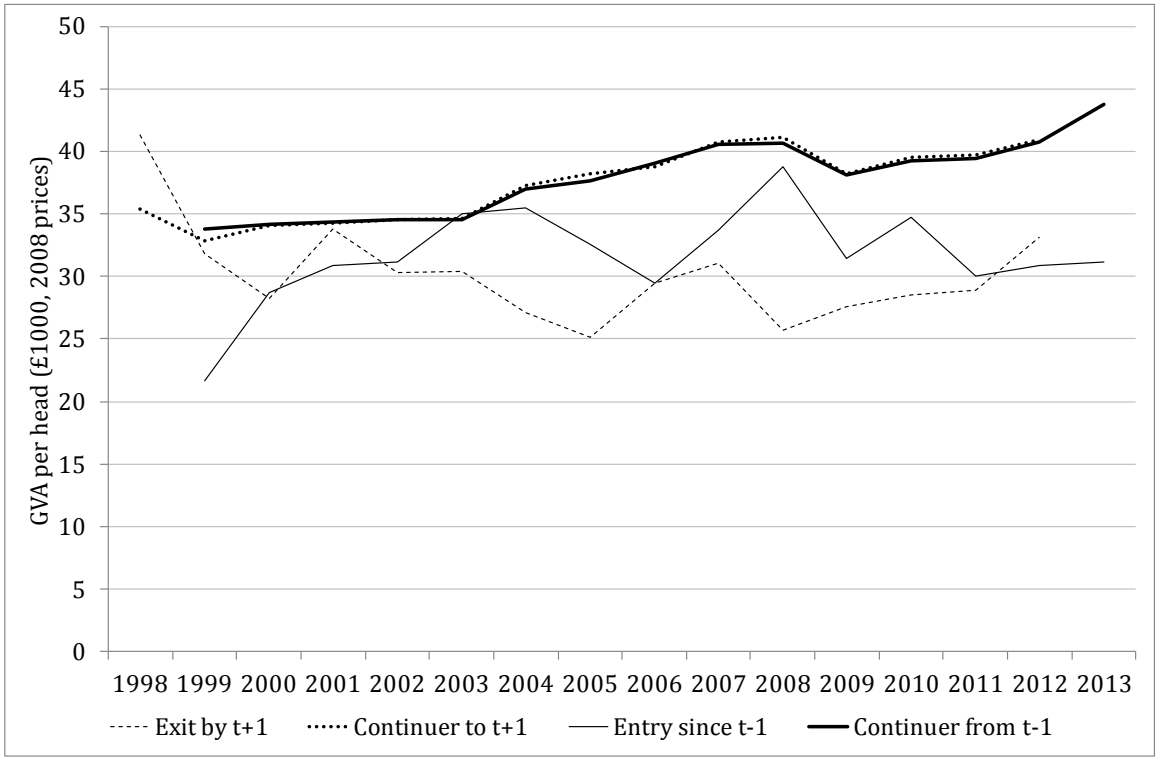
Source: ARD decomposition sample from Annual Respondents Database, ONS, and authors' calculations; ABI & ABS from Annual Business Inquiry and Annual Business Survey published sector data, ONS, and authors' calculations; Market sector from *Productivity*, ONS, April 2015, mnemonic GYY4.
Notes: Labour Productivity Indices, 2007=100. ARD decomposition sample and ABI&ABS cover non-farm non-financial market sectors excluding real estate, mining & quarrying, and utilities sectors. Market sector series covers all market activity. ARD decomposition sample covers Great Britain, i.e. United Kingdom less Northern Ireland. GVA per worker.

FIGURE 4 BUSINESS EXIT AND ENTRY RATES



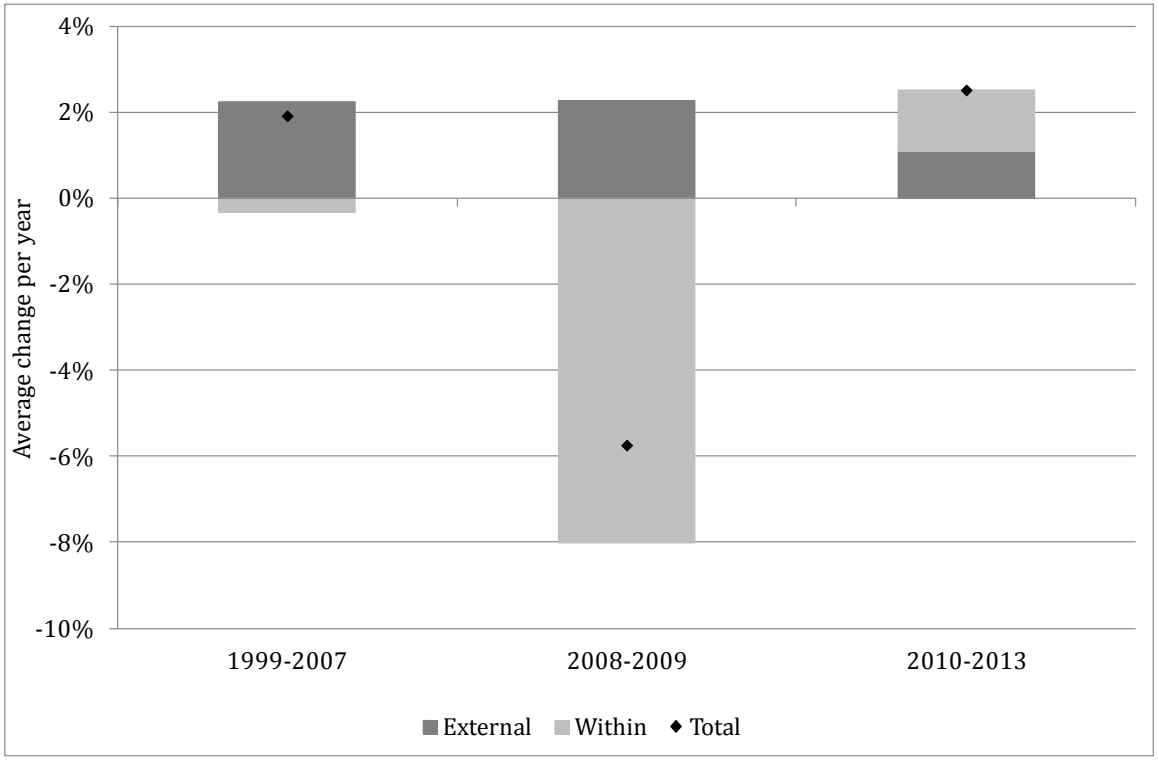
Source: Annual Respondents Database, ONS, and authors' calculations.

FIGURE 5 LABOUR PRODUCTIVITY BY 1 YEAR SURVIVAL STATUS



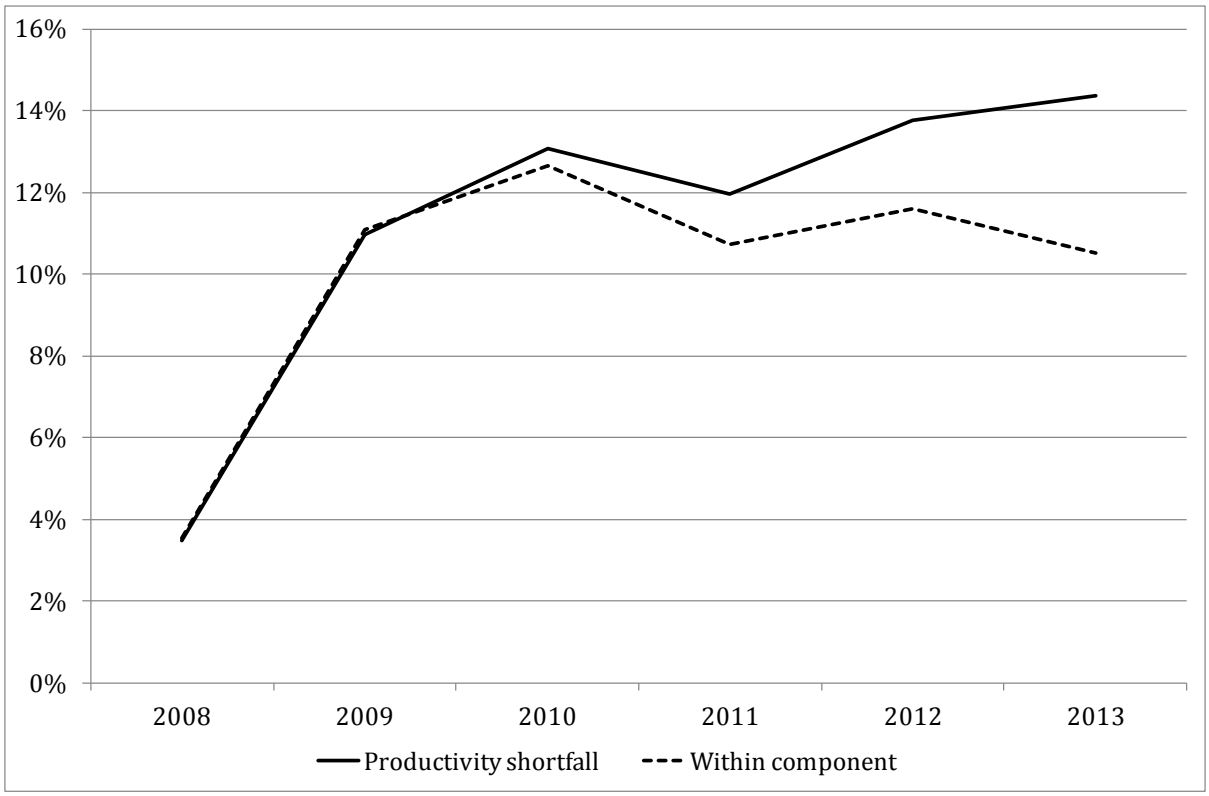
Source: Annual Respondents Database, ONS, and authors' calculations.

FIGURE 6 DECOMPOSITION OF 1-YEAR CHANGES IN LABOUR PRODUCTIVITY



Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: DF decomposition. Growth components Within and External sum to Total. Non-farm non-financial market sectors excluding mining & quarrying, utilities and real estate activities. Britain.

FIGURE 7 LABOUR PRODUCTIVITY DEVIATION FROM A CONTINUATION OF THE PRE-CRISIS TREND



Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: Derived from DF decomposition of annual labour productivity growth. Shown as a 2-year backward looking moving average. Non-farm non-financial market sectors excluding mining & quarrying, utilities and real estate activities. Britain.

TABLE 1 DECOMPOSITION OF CHANGES IN LABOUR PRODUCTIVITY

Changes over		Total	Growth Components				External	
			Within	Between	Entry	Exit	Net Entry	Total
1 year	Average 1998-2007	0.019	-0.003	0.014	0.000	0.009	0.009	0.022
	2007 to 2008	-0.050	-0.074	0.013	-0.001	0.012	0.011	0.024
	Difference	*-0.070*	*-0.071*	*-0.001*	*-0.001*	*0.003*	*0.003*	*0.001*
3 years	Average 1998-2007	0.078	0.020	0.040	0.007	0.012	0.018	0.058
	2007 to 2010	0.001	-0.046	0.036	-0.003	0.013	0.011	0.046
	Difference	*-0.078*	*-0.066*	*-0.004*	*-0.010*	*0.002*	*-0.008*	*-0.012*
4 years	Average 1998-2007	0.103	0.044	0.041	0.009	0.009	0.018	0.059
	2007 to 2011	-0.003	-0.047	0.032	-0.010	0.021	0.011	0.043
	Difference	*-0.106*	*-0.091*	*-0.008*	*-0.019*	*0.012*	*-0.007*	*-0.015*
5 years	Average 1998-2007	0.136	0.073	0.043	0.010	0.011	0.021	0.064
	2007 to 2012	-0.026	-0.054	0.018	-0.028	0.037	0.010	0.028
	Difference	*-0.163*	*-0.127*	*-0.025*	*-0.037*	*0.027*	*-0.011*	*-0.036*
6 years	Average 1998-2007	0.144	0.053	0.059	0.020	0.013	0.033	0.092
	2007 to 2013	0.022	-0.025	0.035	-0.020	0.033	0.013	0.047
	Difference	*-0.122*	*-0.078*	*-0.024*	*-0.040*	*0.020*	*-0.020*	*-0.044*

Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: Average 1998-2007 is an average of all possible changes over 1, 3, 4, 5, or 6 years. DF decomposition. Growth components Within, Between, Entry and Exit sum to Growth Total. Entry and Exit sum to Net entry. Between, Entry and Exit sum to External Total. Non-farm non-financial market sectors excluding mining & quarrying, utilities and real estate activities. Britain.

TABLE 2 DECOMPOSITIONS COMPARED

		Average 1998-2007							Difference from Average 1998-2007				
		Total	Growth Components				External						
Changes over	Decomposition		Within	Between	Entry	Exit	Net Entry	Total	Change	Total	Within	External	External (% of Total)
1 year	DF	0.019	-0.003	0.014	0.000	0.009	0.009	0.022	2007-2008	-0.070	-0.071	0.001	-1%
	MP	0.019	-0.014	0.024	0.000	0.009	0.009	0.033		-0.070	-0.063	-0.007	10%
	GR	0.019	-0.003	0.013	0.001	0.009	0.009	0.022		-0.070	-0.066	-0.003	4%
	FHK	0.019	0.011	-0.002	0.001	0.008	0.009	0.008		-0.070	-0.070	0.000	0%
3 year	DF	0.078	0.020	0.040	0.007	0.012	0.018	0.058	2007-2010	-0.078	-0.066	-0.012	15%
	MP	0.078	0.020	0.040	0.007	0.012	0.018	0.059		-0.078	-0.085	0.007	-9%
	GR	0.078	0.016	0.033	0.012	0.017	0.030	0.063		-0.078	-0.055	-0.022	28%
	FHK	0.078	0.051	0.000	0.019	0.008	0.028	0.027		-0.078	-0.070	-0.007	9%
4 year	DF	0.103	0.044	0.041	0.009	0.009	0.018	0.059	2007-2011	-0.106	-0.091	-0.015	14%
	MP	0.103	0.053	0.032	0.009	0.009	0.018	0.050		-0.106	-0.141	0.034	-32%
	GR	0.103	0.033	0.033	0.017	0.020	0.037	0.070		-0.106	-0.070	-0.036	34%
	FHK	0.103	0.063	0.007	0.027	0.006	0.034	0.040		-0.106	-0.074	-0.032	30%
5 year	DF	0.136	0.073	0.043	0.010	0.011	0.021	0.064	2007-2012	-0.163	-0.127	-0.036	22%
	MP	0.136	0.074	0.042	0.010	0.011	0.021	0.062		-0.163	-0.148	-0.015	9%
	GR	0.136	0.051	0.034	0.023	0.028	0.051	0.085		-0.163	-0.094	-0.068	42%
	FHK	0.136	0.081	0.010	0.039	0.006	0.045	0.055		-0.163	-0.093	-0.069	42%
6 year	DF	0.144	0.053	0.059	0.020	0.013	0.033	0.092	2007-2013	-0.122	-0.078	-0.044	36%
	MP	0.144	0.046	0.066	0.020	0.013	0.033	0.099		-0.122	-0.086	-0.036	30%
	GR	0.144	0.033	0.043	0.034	0.034	0.068	0.111		-0.122	-0.054	-0.069	57%
	FHK	0.144	0.064	0.020	0.054	0.006	0.060	0.081		-0.122	-0.063	-0.059	48%

Source: Annual Respondents Database, ONS, and authors' calculations.

Notes: Average 1998-2007 is an average of all possible changes over 1, 3, 4, 5, or 6 years. Change 2007 onwards shown as difference from average 1998-2007. The FHK between component includes the cross term. Growth components Within, Between, Entry and Exit sum to Growth Total. Entry and Exit sum to Net entry. Between, Entry and Exit sum to External Total. Non-farm non-financial market sectors excluding mining & quarrying, utilities and real estate activities. Britain.

TABLE 3 DECOMPOSITIONS OF ANNUAL LABOUR PRODUCTIVITY GROWTH: TFP AND CAPITAL DEEPENING

		2002-2007	2008-2013	*Difference*	2008-2009	2010-2013
LP	Total	0.017	-0.011	*-0.029*	-0.071	0.019
	Within	0.002	-0.018	*-0.021*	-0.083	0.014
	External	0.015	0.007	*-0.008*	0.012	0.005
TFP	Total	0.011	-0.015	*-0.026*	-0.060	0.007
	Within	0.002	-0.020	*-0.022*	-0.069	0.005
	External	0.009	0.005	*-0.005*	0.009	0.003
Capital deepening	Total	0.006	0.004	*-0.002*	-0.010	0.012
	Within	0.001	0.002	*0.001*	-0.014	0.010
	External	0.006	0.002	*-0.003*	0.003	0.002

Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: Growth components Within and External sum to Total. Establishments with 10 or more employees. Non-farm non-financial market sectors excluding mining & quarrying, utilities and real estate activities. Britain.

TABLE 4 DECOMPOSITION OF 1-YEAR CHANGES IN LABOUR PRODUCTIVITY: CONTRIBUTIONS BY SIZE OF BUSINESS

	Average	Total	Growth Components				External	
			Within	Between	Entry	Exit	Net Entry	Total
All								
	1999-2007	0.019	-0.003	0.014	0.000	0.009	0.009	0.022
	2008-2013	-0.002	-0.017	0.008	-0.007	0.013	0.006	0.015
	Difference	*-0.022*	*-0.014*	*-0.006*	*-0.007*	*0.005*	*-0.002*	*-0.008*
	2008-2009	-0.057	-0.080	0.011	-0.002	0.014	0.012	0.023
	2010-2013	0.025	0.014	0.007	-0.009	0.013	0.004	0.011
SMEs								
	1999-2007	0.005	-0.009	0.007	-0.004	0.011	0.007	0.014
	2008-2013	-0.002	-0.013	0.004	-0.007	0.014	0.006	0.010
	Difference	*-0.007*	*-0.004*	*-0.003*	*-0.003*	*0.003*	*0.000*	*-0.003*
	2008-2009	-0.024	-0.039	0.004	-0.006	0.017	0.012	0.016
	2010-2013	0.008	0.000	0.004	-0.008	0.012	0.003	0.008
Large								
	1999-2007	0.014	0.005	0.007	0.004	-0.002	0.002	0.009
	2008-2013	0.000	-0.004	0.004	0.001	0.000	0.000	0.004
	Difference	*-0.014*	*-0.009*	*-0.003*	*-0.003*	*0.002*	*-0.002*	*-0.005*
	2008-2009	-0.034	-0.041	0.007	0.004	-0.003	0.001	0.007
	2010-2013	0.017	0.014	0.003	-0.001	0.001	0.000	0.003

Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: DF decomposition. Growth components Within, Between, Entry and Exit sum to Growth Total. Entry and Exit sum to Net entry. Between, Entry and Exit sum to External Total. Non-farm non-financial market sectors excluding mining & quarrying, utilities and real estate activities. Britain. SMEs defined as firms with less than 250 employees. SMEs and Large sum to All.

TABLE 5 DECOMPOSITION OF 1-YEAR CHANGES IN LABOUR PRODUCTIVITY BY MAIN SECTOR

	1999-2007			2008-2009			2010-2013		
	Within	External	Total	Within	External	Total	Within	External	Total
Accomodation & Food	0.000	0.015	0.016	-0.071	0.036	-0.036	0.022	-0.003	0.019
Construction	-0.040	0.037	-0.004	-0.132	0.029	-0.103	0.012	0.039	0.051
Wholesale & Retail	-0.007	0.025	0.018	-0.079	0.019	-0.061	-0.004	0.014	0.010
Manufacturing	0.005	0.025	0.031	-0.086	0.019	-0.067	0.033	0.003	0.036
Transport & Storage	-0.005	0.010	0.005	-0.078	0.027	-0.051	-0.005	0.013	0.008
Arts & Entertainment	-0.004	0.006	0.002	-0.031	0.013	-0.018	0.007	0.010	0.017
Administration & Support	0.017	0.025	0.042	-0.072	0.003	-0.069	0.038	0.002	0.040
Professional & Scientific	0.003	0.029	0.032	-0.096	0.053	-0.043	0.022	0.016	0.038
Information & Communication	0.009	-0.006	0.004	-0.056	0.021	-0.035	0.009	0.001	0.010
All	-0.003	0.022	0.019	-0.080	0.023	-0.057	0.014	0.011	0.025

Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: DF decomposition. Growth components Within and External sum to Total. External equals the contribution of market share shifts between surviving companies, entry and exit. Britain.

TABLE 6 EMPLOYMENT GROWTH AND FIRMS' LABOUR PRODUCTIVITY POSITION

DPV	Δ log(1+EMP)		Δ EMPShare		Exit		Entry	
LP	0.0279***	(5.43)	0.00034***	(4.74)	-0.0813***	(5.37)	-0.0097	(1.01)
LP x 2008-2013	-0.0167***	(2.89)	-0.00023***	(2.89)	-0.0129	(0.67)	-0.0229	(1.86)
LP	0.0279***	(5.44)	0.00034***	(4.75)	-0.0813***	(5.38)	-0.0097	(1.01)
LP x 2008-2009	-0.0180***	(2.94)	-0.00016	(1.46)	-0.0173	(0.77)	-0.0153	(1.29)
LP x 2010-2013	-0.0161***	(2.80)	-0.00027***	(3.57)	-0.0101	(0.52)	-0.0274**	(2.08)
LP	0.0081	(0.99)	0.00051**	(2.05)	-0.0472*	(1.88)	-0.0257	(1.28)
LP x 2008-2013	-0.0029	(0.28)	-0.00032	(1.26)	-0.0050	(0.09)	-0.0130	(0.49)
LP x BD	0.0561**	(2.60)	-0.00047	(0.79)	-0.0948	(0.95)	0.0440	(0.73)
LP x BD x 2008-2013	-0.0394	(1.44)	0.00027	(0.44)	-0.0177	(0.11)	-0.0281	(0.35)
LP	0.0081	(1.00)	0.00051**	(2.06)	-0.0472*	(1.89)	-0.0257	(1.28)
LP x 2008-2009	0.0078	(0.86)	-0.00007	(0.24)	-0.0159	(0.31)	-0.0228	(0.84)
LP x 2010-2013	-0.0070	(0.62)	-0.00045*	(1.77)	0.0005	(0.01)	-0.0077	(0.28)
LP x BD	0.0561**	(2.61)	-0.00047	(0.80)	-0.0948	(0.95)	0.0440	(0.73)
LP x BD x 2008-2009	-0.0736***	(2.96)	-0.00026	(0.37)	0.0000	(0.00)	0.0177	(0.22)
LP x BD x 2010-2013	-0.0265	(0.89)	0.00052	(0.86)	-0.0256	(0.15)	-0.0540	(0.66)
Observations	161164		161164		186631		201925	

Source: ARD, FAME

Notes: Sample period 1998-2013. LP measures the percentage deviation of a firm's labour productivity from the industry year average for surviving firms. BD measures industry bank dependence calculated as the share of assets due to SMEs with bank finance by 2-digit industry 2005-2007 (calculated from company accounts data in FAME; 31 industry sectors; sector mean=0.33, sd=0.15, median=0.36). t-stats in brackets calculated using robust standard errors clustered at the industry sector level and time period. Controls for firm size effects and industry-year effects included. Population weighted. Columns 1 and 2 consider continuing firms. Column 3 estimated on the sample of continuing and exiting firms. Column 4 estimated on the sample of continuing and entering firms.

TABLE 7 MANUFACTURING RECESSIONS COMPARED:
DECOMPOSITION OF 5-YEAR CHANGES IN LABOUR PRODUCTIVITY

	Total	Growth components				External		Sample sizes (unweighted)		
	%	Within	Between	Entry	Exit	Net entry	Total	Continuers	Entrants	Exits
1984-1989	20.8	16.5	0.4	2.7	1.1	3.8	4.2	9582	5129	4154
1989-1994	19.8	17.9	0.6	2.6	-1.3	1.3	1.9	6402	2072	5148
difference	*-1.0*	*1.3*	*0.2*	*0.0*	*-2.4*	*-2.5*	*-2.3*			
2002-2007	33.7	19.7	6.0	2.5	5.6	8.1	14.1	2761	1197	2277
2007-2012	0.0	-6.4	2.5	1.5	2.3	3.8	6.3	1828	544	1549
difference	*-33.8*	*-26.0*	*-3.4*	*-1.0*	*-3.3*	*-4.3*	*-7.7*			
difference 2007-2012 to 1989-1994	-19.8	-24.2	1.9	-1.1	3.6	2.5	4.4			
difference 2007-2012 to 2002-2007 less difference 1989-94 to 1984-1989	-32.8	-27.3	-3.6	-1.0	-0.8	-1.8	-5.5			

Memo items	% GVA growth (Manufacturing)	Unemployment change (Whole economy)	Employment shares Entrants	Exits
1984-1989	14.4	-4.2	0.164	0.207
1989-1994	-3.9	2.7	0.165	0.252
difference	*-18.3*	*6.9*	*0.001*	*0.045*
2002-2007	-1.3	-0.4	0.174	0.328
2007-2012	-9.4	2.1	0.143	0.212
difference	*-8.1*	*2.5*	*-0.031*	*-0.117*
difference 2007-2012 to 1989-1994	-5.5	-0.6	-0.022	-0.040
difference 2007-2012 to 2002-2007 less difference 1989-94 to 1984-1989	10.2	-4.4	-0.032	-0.162

Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: DF decomposition. Growth components Within, Between, Entry and Exit sum to Growth Total. Entry and Exit sum to Net entry. Between, Entry and Exit sum to External Total. Britain. Firms are classified as live if they are active and have 20 or more persons employed.

TABLE 8 MANUFACTURING RECESSIONS COMPARED:
EMPLOYMENT GROWTH AND FIRMS' LABOUR PRODUCTIVITY POSITION

DPV	Δ log(1+EMP)		Δ EMPShare		Exit		Entry	
LP	0.0937***	(4.05)	0.00602**	(2.15)	0.0084	(0.67)	0.0488***	(2.78)
LP x recession	-0.0081	(0.27)	0.00157	(0.37)	-0.0337	(1.62)	0.0147	(0.66)
LP x 2000s	0.0492	(1.53)	0.01063	(1.60)	-0.0568**	(2.53)	-0.0168	(0.78)
LP x recession x 2000s	-0.0313	(0.71)	-0.01324*	(1.72)	0.0116	(0.38)	-0.0100	(0.34)
Observations	20573		20573		33701		29515	

Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: Start years included in the sample: 1984, 1989, 2002, 2007. LP measures the percentage deviation of a firm's labour productivity from the industry year average for surviving firms. t-stats in brackets calculated using robust standard errors clustered at the industry sector level and time period. Controls for firm size effects and industry-year effects included. Population weighted.

APPENDIX A

TABLE A1 EMPLOYMENT AND NUMBER OF ESTABLISHMENTS IN THE ARD POPULATION, BY SIZE OF ESTABLISHMENT

Establishment size (numbers employed)		Employment *(millions)*	No. of establishments *(thousands)*
Micro	(0-9)	3.3	1345
Small	(10-49)	2.7	140
Medium	(50-249)	2.4	23
Large	(250+)	7.3	6

Source: ARD and authors' calculations

Notes: Average 1998-2013; Non-farm-non-financial market sectors excl. mining & quarrying, utilities and real estate activities.

TABLE A2 ARD SAMPLE FOR DECOMPOSITION ANALYSIS, BY SIZE OF ESTABLISHMENT AND SURVIVOR/EXIT STATUS

Establishment size (numbers employed)		Survival status	Employment		No. of establishments	
			Sample count (thousands)	*% of population*	*Sample count*	*% of population*
Micro	0-9	Exitors	15.9	1.08	6643	1.03
		Continuers	0.5	0.03	118	0.02
Small	10-49	Exitors	73.0	8.81	3305	7.36
		Continuers	27.1	1.52	999	1.09
Medium	50-249	Exitors	252.6	34.42	2220	30.9
		Continuers	268.8	16.66	2139	13.34
Large	250+	Exitors	1882.5	79.51	1459	74.38
		Continuers	4081.8	83.39	2613	69.47

Source: ARD and authors' calculations.

Notes: Average 1998-2013. Survivor/exit status evaluated over 6 years. Non-farm-non-financial market sectors excl. mining & quarrying, utilities and real estate activities. Due to the practice of selecting survey observations for a two year period (each year 50% of the sample is replaced) longitudinal sampling probabilities may be larger for consecutive years than those shown here, except in the case of micro businesses where longitudinal sampling probabilities will be smaller than those shown here whenever there are less than three years between surveys (Bovill, 2012). Mostly firms are not re-sampled for at least two years after appearing in the sample, therefore longitudinal sampling probabilities may be smaller than shown here when there is only a one or two year gap between survey years. For large firms the survey is carried out as a census. Survey observations amount to less than 100% of population observations for large establishments in part due to non-response.

APPENDIX B

To illustrate the dynamics underlying developments in aggregate economy productivity we use the dynamic productivity decomposition proposed by DF as described in equation (2) in the main text. We also report estimates based on other decompositions that are more commonly used in the literature. Here we list the formulas for each of these.[32]

The MP decomposition:

(B1)
$$\begin{aligned}\Delta\Pi_t = & \tfrac{1}{1-\overline{cov}_C}\textstyle\sum_{i\in C}\frac{1}{n_C}\Delta\pi_{it} \\ & + \tfrac{\bar{\Pi}_C}{1-\overline{cov}_C}\Delta cov_{Ct} \\ & + \textstyle\sum_{i\in N} s_{it}(\pi_{it} - \Pi_{Ct}) \\ & - \textstyle\sum_{i\in X} s_{i,t-k}(\pi_{i,t-k} - \Pi_{C,t-k}) \qquad \text{(MP)}\end{aligned}$$

where $cov_{Ct} = \frac{1}{\Pi_{Ct}}\sum_{i\in C}\left(s_{Cit} - \frac{1}{n_C}\right)(\pi_{it} - \sum_{i\in C}\frac{1}{n_C}\pi_{it})$; n_C is the number of continuing firms.[33]

The GR decomposition:

(B2)
$$\begin{aligned}\Delta\Pi_t = & \textstyle\sum_{i\in C}\bar{s}_i\Delta\pi_{it} \\ & + \textstyle\sum_{i\in C}\Delta s_{it}(\bar{\pi}_i - \bar{\Pi}) \\ & + \textstyle\sum_{i\in N} s_{it}(\pi_{it} - \bar{\Pi}) \\ & - \textstyle\sum_{i\in X} s_{i,t-k}(\pi_{i,t-k} - \bar{\Pi}) \qquad \text{(GR)}\end{aligned}$$

The FHK decomposition:

(B3)
$$\begin{aligned}\Delta\Pi_t = & \textstyle\sum_{i\in C} s_{i,t-k}\Delta\pi_{it} \\ & + \textstyle\sum_{i\in C}\Delta s_{it}(\pi_{i,t-k} - \Pi_{t-k}) + \sum_{i\in C}\Delta s_{it}\Delta\pi_{it} \\ & + \textstyle\sum_{i\in N} s_{it}(\pi_{it} - \Pi_{t-k}) \\ & - \textstyle\sum_{i\in X} s_{i,t-k}(\pi_{i,t-k} - \Pi_{t-k}) \qquad \text{(FHK)}\end{aligned}$$

[32] Population-weighted versions of these can be found in Riley, Rosazza & Young (2014).

[33] The MP decomposition shown here is for the case where productivity is measured in levels rather than in logs, because our main results consider the levels case. When π_{it} measures log productivity we use the standard MP decomposition specified as:

$$\Delta\Pi_t = \sum_{i\in C}\frac{1}{n_C}\Delta\pi_{it} + \Delta cov_{Ct} + \sum_{i\in N} s_{it}(\pi_{it} - \Pi_{Ct}) - \sum_{i\in X} s_{i,t-k}(\pi_{i,t-k} - \Pi_{C,t-k})$$

where $cov_{Ct} = \sum_{i\in C}\left(s_{Cit} - \frac{1}{n_C}\right)(\pi_{it} - \sum_{i\in C}\frac{1}{n_C}\pi_{it})$.