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## Discussion paper

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# Productivity Dynamics in the Great Stagnation: Evidence from British businesses

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**Abstract**

We investigate labor productivity dynamics amongst British businesses in the wake of the credit crisis of 2007/8. The external restructuring of firms (i.e. changes in market share, firm entry and exit) contributed to a fall in productivity growth relative to trend amongst small businesses in bank dependent industries, consistent with the idea that an adverse credit supply shock caused inefficiencies in resource allocation across firms. But, the major part of the decline in UK productivity growth following the credit crisis was accounted for by a widespread productivity shock *within* firms, pointing to the importance of other factors in explaining the Great Stagnation.

**Keywords:** productivity growth, reallocation, Great Recession and Stagnation, credit shock
**JEL codes:** L11, O47, E32

# 1    INTRODUCTION

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. Several empirical studies suggest that such changes in the composition of the business population account for a significant part of both labor and total factor productivity (TFP) growth.[1] A separate empirical literature suggests that recessions that are 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). Why financial crises should lead to permanent losses of output is probably less well understood, although there are a number of channels through which an impaired financial system is thought to influence the wider economy (see e.g. Cecchetti *et al.*, 2009). 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. For example, in a banking crisis, firms that rely on banks to finance their activities become credit constrained, which may prevent them from expanding their otherwise viable operations. New firms may be unable to enter the market if this requires a capital outlay upfront, reducing competitive pressures on incumbent firms. Banks may forbear bad debtors, thereby delaying the process of company closure in an effort to preserve their own balance sheets. Yet despite some compelling arguments and popular suggestion, there is little evidence on the importance of these types of distortions to resource allocation in terms of enhancing the severity of recessions and weakening the productive potential of the economy when recessions are accompanied by a banking crisis. In this paper we help fill this gap, investigating to what extent inefficiencies in resource allocation across businesses are likely to explain the weakness of productivity in the aftermath of the global financial crisis of 2007/8.

Specifically, we document how the weakness of productivity growth in the United Kingdom following the financial crisis can be accounted for by shifts in the distribution of firm-level productivity and by changes in the composition of the business population, respectively. This is a simple accounting exercise. Our objective is to assess whether in the wake of the credit crisis compositional effects represented a significant drag on productivity growth. Based on this decomposition analysis we highlight the extent to which the stagnation in productivity since the

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[1] 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 labor 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 labor productivity growth and 80-90% of establishment TFP growth. Bartelsman, Haltiwanger & Scarpetta (2013) suggest that cross country differences in allocative efficiency imply substantial differences in cross-country productivity performance.

financial crisis may be due to resource misallocation between existing firms and a lack of creative destruction or cleansing effect of recession, as might be expected in a banking crisis, or a widespread productivity shock, which may or may not be directly associated with the credit crunch, but which is not obviously directly related to the efficiency with which resources are allocated across more and less productive firms.[2]

To illustrate these patterns in the contributions to aggregate productivity performance of within firm changes in productivity and external restructuring (firm entry, exit and changes in market share) we propose a hybrid of the decomposition techniques put forward by Melitz & Polanec (2012) (MP) and Griliches & Regev (1995) (GR) and use it to decompose UK labor productivity in the aftermath of the most recent recession. As emphasised by MP, the widely used decompositions methods of GR and of Foster, Haltiwanger & Krizan (2001) (FHK) tend to exaggerate the aggregate productivity contribution of firm entry in a growth economy. In our context this implies that when the economy moves from a situation where productivity is rising (e.g. before the Great Recession) to one where productivity is falling (during the Great Recession), the FHK and GR decompositions lead to a reduction in the contribution of entering firms to aggregate productivity growth that is unrelated to the efficiency of resource allocation between new and existing firms. The dynamic Olley-Pakes decomposition suggested by MP avoids this, but leads to a disconnect between the evaluation of reallocation that is due to firm entry and exit and reallocation that is due to shifts in market share amongst ongoing firms. Moreover, the dynamic Olley-Pakes decomposition is relatively sensitive to the idiosyncratic behaviour of small businesses and, as a result, more prone to measurement error when applied to small samples. The decomposition we propose avoids the pro-cyclicality of the aggregate productivity contribution of firm entry inherent to the decompositions of GR and FHK, whilst retaining comparability between the different elements of reallocation and the robustness to measurement error that is achieved by weighting the contributions of ongoing firms by their market share.

We study the experience of British businesses. Although the financial crisis of 2007/8 originated in the US sub-prime mortgage market, 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). Recovery from the recessions that occurred across advanced economies has been a slow process, and in many economies a key feature of the recovery has been the failure of productivity to rebound (ONS,

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[2] A banking crisis, and credit constraints per se, may affect aggregate productivity by changing productivity within and between firms. In this paper we do not intend to test whether or not the banking crisis affected economic performance, which it invariably did, but are focusing on the mechanisms through which this may have occurred. Distinctions between these mechanisms are important as they may suggest different remedial action for policy.

2014). Five years after the financial crisis, productivity remained 8-9% below a simple extrapolation of its pre-crisis trend in France and in Germany. In the US, Canada and Japan, this deviation was smaller at around 3-5%. Productivity weakness has been particularly evident in the UK, where in 2012 the gap between trend and actual labor productivity stood at around 15%. This picture contrasts very sharply with the experience of other UK recessions in the last 50 years, when the drop in productivity was less steep and recovery quicker. While this weakness in productivity is not well understood, the tightening of credit conditions points to one potential contributing factor. By 2012 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). A number of studies have highlighted the sensitivity of investment by UK firms to the availability of finance.[3] Pessoa & Van Reenen (2014) suggest that a combination of increasingly flexible wages in the UK (Gregg & Machin, 2014) and the increased cost of finance for some companies may have led them to substitute labor for capital resulting in weaker labor productivity growth. There is also evidence to suggest that UK banks engaged in forbearance (Arrowsmith *et al.*, 2013). In sum, Britain in the aftermath of 2007/8 provides a useful testing ground for examining the linkages between banking crises, resource allocation and productivity.

We make use of the UK Annual Respondents Database (ARD), assessing labor productivity growth for the period 2007-2011 and comparing this to labor productivity growth in the pre-recession years 2003-2007 and in earlier periods. For manufacturing we are able to compare the Great Recession to an earlier recession, which was not instigated by a financial crisis. To further probe the likely causes of recent UK productivity weakness we distinguish between the experience of smaller enterprises, which are typically more dependent on bank finance, in more and less bank dependent sectors. We draw a number of conclusions. First, we find that aggregate productivity weakness in the UK during the Great Stagnation is a phenomenon that is associated with widespread productivity weakness within firms. It does not appear to be the case that this is associated with a sharp reduction in the productivity contributions from external restructuring. On the face of it this does not suggest that, in and of themselves, credit constraints and bank forbearance have been key in explaining the weakness of aggregate UK labor productivity. We say this because we would expect these factors to reduce the contribution of external restructuring to labor productivity growth. Credit constraints and bank forbearance may of course also influence productivity weakness within firms and we do not intend to rule this out. Second, we do find patterns in the data that are consistent with the

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[3] For example, 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.

suggestion that the credit crunch lessened the contributions to productivity of external restructuring relative to what we might have expected in a 'normal' recession. For example, the productivity contribution of resource reallocation did fall sharply amongst smaller businesses in bank dependent service sectors. This is very different to the experience in service sectors that rely less on bank finance. We also find some suggestive evidence that the efficiency of resource allocation was impaired in manufacturing relative to what we might have expected based on the historical data. These findings indicate that there is an empirical link between banking crises and the efficiency of resource allocation, which feeds through to aggregate productivity. But, in terms of explaining recent developments in aggregate productivity these linkages are of relatively little importance, certainly when contrasted with the large productivity declines observed within businesses. We do not explore alternative explanations for productivity weakness since the credit crunch. But, on the basis of these results we conclude that other factors, for example general demand weakness, uncertainty, and wider forbearance are likely to be more important in explaining the Great Stagnation and the influence of banking crises on economic outcomes.

Our study is related to other studies that analyse the pattern of productivity dynamics in the wake of financial crisis. Griffin and Odaki (2009) look at the dramatic slowdown of economic growth in Japan during the 1990s. Using similar methods to those we adopt here they explore the importance of Japanese banks' support for inefficient firms in explaining the weakness of Japanese productivity growth during the 1990s. Their main results show that the weakness of Japanese productivity growth was associated with a significant drop in within-firm productivity rather than with an absence of the cleansing effects of recession (i.e. the downsizing/exits of less productive firms). These findings are not dissimilar to those reported in this paper. Their analysis concerns large manufacturing firms; data limitations mean that they do not capture entry effects. Using regression analysis Foster, Grim & Haltiwanger (2013) study reallocation dynamics amongst US manufacturing firms during the Great Recession and find that these have been less productivity enhancing in comparison to previous recessions. In particular, before the Great Recession they find that the positive relationship between TFP levels and firm growth and survival is counter-cyclical. But this does not appear to be the case during the Great Recession, which the authors take as evidence that during the Great Recession reallocation was less "cleansing". As the authors point out, it is difficult to draw conclusions about the aggregate productivity consequences of their findings, but in a counterfactual exercise they suggest these differences may account for a substantial reduction in annual TFP growth. While our findings do

not rule out this type of link, our findings point to the importance of other linkages between banking crises and productivity.[4]

The structure of the paper is as follows. The next section discusses why banking crises might affect resource reallocation. Section 3 outlines the methodology for the analysis. Section 4 describes the data and basic trends. Results are described in section 5. Section 6 concludes.

## 2      BANKING CRISES AND RESOURCE ALLOCATION

There are good reasons to think that the impacts of a banking crisis on economic performance are 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 (Bartelman, Haltiwanger & Scarpetta, 2013). For example, by preventing high productivity but bank dependent firms from expanding 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 or allowing them to maintain market share.

These ideas are also 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 of recession may be depressed 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

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[4] Bank of England research carried out independently of this study (see Barnett *et al.*, 2014) decomposes annual UK labor productivity growth during the Great Recession using the adaptation of the Griliches & Regev (1995) decomposition described in Baily, Bartelsman & Haltiwanger (2001). They find that much of the decline in UK labor productivity growth since 2007 arises due to productivity stagnation within firms, similar to our findings. They also suggest that less efficient reallocation and a slowdown in creative destruction during the Great Recession explains a third of the gap between actual and trend productivity in the UK. We suggest that differences to the conclusions reached there are likely to depend in part on the decomposition method used, the time horizon considered, and differences in the specifics of the data.

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. Labor 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 reduces aggregate capital investment and labor 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. The effect of this inefficient allocation of capital is to dampen aggregate labor productivity.

Bank forbearance is another channel by which a financial crisis might distort resource allocation between firms, leading to the existence of zombie companies as troubled banks seek to avoid crystallising losses on their balance sheets. This type of behavior 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.

To summarise, although the channels through which banking crises and credit constraints affect firm performance and aggregate productivity may be manifold, the studies outlined above suggest that inefficiencies in resource allocation are likely to be an important part of the story. This holds true because credit constraints affect heterogeneous firms differently. Not all companies are equally dependent on bank finance or credit rationed. At this point it is important to point out that the productivity effects of resource misallocation caused by credit constraints may not be confined to the distinct contributions to aggregate productivity change of compositional effects (external restructuring). For example, if credit constraints restrict firm entry or the expansion of young dynamic firms, productivity growth of incumbents or older firms may be reduced due to weaker competitive pressures (Aghion et al., 2009). These

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effects should reduce the contribution to aggregate productivity of external restructuring, but they may also reduce the contribution to aggregate productivity of within firm growth (directly for young firms, and potentially indirectly for older firms that face less competition). Nevertheless, if the allocative efficiency channel is an important transmission mechanism between banking crises and real economic performance, then we should observe this in the contribution to productivity change of business restructuring.

## 3 PRODUCTIVITY GROWTH DECOMPOSITIONS

We now turn to the decomposition of aggregate productivity growth into that which happens because of changes in productivity growth within businesses and that which happens because of the reallocation of market share across businesses. Our main interest is in exploring how the importance of reallocation dynamics for productivity growth has changed since the financial crisis, with a view to better understanding the way that banking crises impact on the real economy. To this end we combine features of the decomposition proposed by GR and the decomposition proposed more recently by MP. As in much of the empirical literature we decompose aggregate productivity growth into four terms. The first term, the within effect, shows the contribution to aggregate productivity growth which comes about via productivity changes within continuing (C) firms, those that exist at both the start and end of the period, holding market shares fixed. The second term, the between effect or reallocation term, shows the contribution to aggregate productivity growth from changes in market share amongst these same continuing firms, for given productivity levels. This term is positive if more productive firms gain market share and less productive firms lose market share. The third and fourth terms show the contribution to aggregate productivity growth of new entrants (N), those firms that exist at the period end, but which were not yet born at the period start and of exitors (X), those firms that exist at the period start and die before the period end. The contribution to aggregate productivity growth of entrants (exitors) is positive if their productivity exceeds (is less than) the average productivity of incumbents (survivors). 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 theory suggests is likely to be suppressed when a banking crisis impairs the efficiency of resource allocation.

More formally, we write aggregate labor productivity at time $t$ ( $\Pi_t$ ) as a weighted average of the level of labor productivity of individual firms ($\pi_{it}$):

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

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 $\Pi_t$ equals the ratio of aggregate gross value added (or output) to aggregate employment, mirroring the measurement of labor productivity based on aggregate data. For continuing firms we can also 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 labor productivity between time $t$-$k$ and time $t$ as:

(2) $\qquad \Delta\Pi_t = \sum_{i \in C} \overline{s}_{Ci} \Delta\pi_{it}$

$\qquad\qquad\qquad + \sum_{i \in C} \Delta s_{Cit} (\overline{\pi}_i - \overline{\Pi}_C)$

$\qquad\qquad\qquad + \sum_{i \in N} s_{it} (\pi_{it} - \Pi_{Ct})$

$\qquad\qquad\qquad - \sum_{i \in X} s_{i,t-k} (\pi_{i,t-k} - \Pi_{C,t-k}) \qquad\qquad$ (HYBRID)

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 labor productivity for continuing firms only, equivalent to aggregate labor productivity for this subset of firms. In (2) the first sum is the within component, the second sum the between component, and the penultimate and last sums the productivity contributions from entry and exit respectively.

The entry and exit components in (2) are identical to the entry and exit components of the MP decomposition, shown in equation (3). MP argue that the widely used productivity growth decompositions of FHK and their adaptation of GR tend to overstate the contribution of net entry to aggregate productivity growth in an economy where productivity is generally rising. This is because in FHK and GR the productivity of entrants at time $t$ is benchmarked against average productivity measured at an earlier 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 entering firms. This is important in our context because it implies that when the economy moves from a situation where productivity is rising (e.g. before the Great Recession) to one where productivity is falling (during the Great Recession), the FHK and GR decompositions will lead to an automatic reduction in the contribution of entering firms to aggregate productivity growth that will have little to do with a drop in the efficiency of resource allocation between new and existing firms. In other words, in the economic environment that we analyse, the FHK and GR estimates of the change in the entry contribution are biased downwards. (When this change is negative the magnitude of this change is biased upwards.) The MP decomposition eliminates this bias by benchmarking the productivity of entering (and exiting) firms on the productivity of continuing firms at the time of entry (or exit).

(3)
$$\Delta\Pi_t = \frac{1}{1-\overline{cov}_C}\sum_{i\in C}\frac{1}{n_C}\Delta\pi_{it}$$

$$+\frac{\bar{\Pi}_C}{1-\overline{cov}_C}\Delta cov_{Ct}$$

$$+\sum_{i\in N}s_{it}(\pi_{it}-\Pi_{Ct})$$

$$-\sum_{i\in X}s_{i,t-k}(\pi_{i,t-k}-\Pi_{C,t-k}) \qquad\qquad\text{(MP)}$$

While in terms of the specification of the entry and exit contributions to aggregate productivity growth the decomposition in (2) is identical to that proposed by MP shown in equation (3), they differ in their evaluation of the within and between contributions of continuing firms. In the MP decomposition the contribution of survivors is divided into a within and a between effect using the decomposition of Olley & Pakes (1996) at time *t* and time *t-k*. The within component (the first sum in (3)) reflects the change in the unweighted mean of productivity for continuing firms; $n_C$ denotes the number of continuing firms. The between component (the second sum in (3)) reflects the change over time in a covariance-like measure between market share and productivity for continuing firms, $cov_{Ct} = \frac{1}{\Pi_{Ct}}\sum_{i\in C}\left(s_{Cit}-\frac{1}{n_C}\right)(\pi_{it}-\sum_{i\in C}\frac{1}{n_C}\pi_{it})$.[5] 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 GR decomposition, shown in equation (4), is more appealing in this respect.[6] Also note that the MP measure of the within component is very different to the GR (and FHK) equivalent in that it evaluates this contribution using an unweighted rather than a share-weighted mean. This increases the influence of small firms, which are typically very heterogeneous, on MP based estimates of the within and between components. As a result, we find that MP based estimates of these components are more volatile across time periods and data samples than the GR and FHK based estimates, at least when estimated on the British survey data, which is dominated by small firms with relatively high grossing weights due to the nature of sampling.

(4)
$$\Delta\Pi_t = \sum_{i\in C}\bar{s}_i\Delta\pi_{it}$$

$$+\sum_{i\in C}\Delta s_{it}(\bar{\pi}_i-\bar{\Pi})$$

$$+\sum_{i\in N}s_{it}(\pi_{it}-\bar{\Pi})$$

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[5] 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 productivity is measured in logs the MP decomposition is a little simpler, avoiding the scaling terms on the change in the mean and covariance for continuing firms.

[6] Note that comparability of measurement of the contributions of external restructuring at the intensive and extensive margins is complicated by the cross term in the FHK decomposition.

$$-\sum_{i\in X} s_{i,t-k}(\pi_{i,t-k} - \overline{\Pi}) \qquad\qquad \text{(GR)}$$

For these reasons our preferred decomposition combines features of the GR and MP decompositions as shown in equation (2). In this hybrid decomposition we follow MP in using a different reference productivity for different groups of firms (entrants, exitors and stayers), avoiding the biases that result from comparing the productivity of one set of firms on the productivity of another set of firms measured at a different point in time. In evaluating the within and between contributions of continuing firms we use a modified version of the GR approach. As in MP, these contributions are independent of the performance and market shares of entering and exiting firms. This is because we normalise continuing firms' market share on the total market share of continuers and because the reference productivity used in calculating the between effect for continuers is a continuer average rather than a population average.[7] But, the within effect is calculated using a share-weighted mean, avoiding the volatility of estimates produced using the unweighted mean and making more comparable the measurement of the different elements of external restructuring.

(5)
$$\Delta\Pi_t = \sum_{i\in C} s_{i,t-k}\Delta\pi_{it}$$

$$+ \sum_{i\in C} \Delta s_{it}(\pi_{i,t-k} - \Pi_{t-k}) + \sum_{i\in C} \Delta s_{it}\Delta\pi_{it}$$

$$+ \sum_{i\in N} s_{it}(\pi_{it} - \Pi_{t-k})$$

$$- \sum_{i\in X} s_{i,t-k}(\pi_{i,t-k} - \Pi_{t-k}) \qquad\qquad \text{(FHK)}$$

In what follows we report our main results using the decomposition in equation (2) (HYBRID), but also report the MP, GR and oft used FHK decomposition for comparison. The FHK decomposition, shown in equation (5), includes an additional term (the third sum in (5), the "cross" firm component), which captures the covariance between changes in market shares and changes in productivity amongst continuing firms. Following Disney *et al.* (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. In calculating the contributions to aggregate productivity growth of external restructuring the FHK decomposition benchmarks firms' productivity against aggregate productivity at the start of the period, i.e. at time *t-k*. In contrast, the GR decomposition benchmarks firms' productivity against aggregate productivity averaged across the start and end periods, as shown in equation (4) where a bar above a variable denotes an average across time *t* and time *t-k*. As discussed in FHK and Disney *et al.* (2003), the time averaging of productivity levels and market shares in the GR

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[7] This benchmarking is actually superfluous in equation (2), because by definition $\sum_{i\in C} \Delta s_{Cit} = 0$, but it facilitates comparison of the decomposition in (2) with existing decomposition methods available in the literature.

decomposition tends to reduce measurement error, but may partly obscure the distinction between internal and external restructuring. The GR decomposition is perhaps particularly attractive due to its simplicity.

The firm-level productivity measure used in the decomposition literature is more often than not a log than a levels measure. Here we use a levels measure of productivity for two reasons. First, gross value added may be zero or negative for some firms and the characteristics of such firms change during recession. We want to include these firms in the analysis.[8] 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 decompositions into percentage changes by dividing all terms in equations (2)-(5) 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 below and do not alter our main conclusions.

## 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 Census Bureau (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). The ARD is in some respects comparable to the US Annual Survey of Manufacturing, including information on output and input use, employment and investment. But it is broader in scope, since 1997 covering also establishments in the service sectors. This is significant because manufacturing establishments account for a fairly small and declining share of value added in many of the more advanced economies[9] that suffered a severe shock as a consequence of the global financial crisis and because productivity dynamics may differ across sectors (see e.g. FHK; Foster *et al.*, 2002).

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[8] This can be done, up to a point, by a simple additive transformation of GVA. But, this becomes less attractive the larger the additive factor required. In assessing the robustness of our results to a log measure of firm productivity we add £1000 to firms' GVA before taking logs and truncate the bottom end of the 1-digit industry distribution of GVA per head uniformly in each year. An alternative is to measure firms' output using gross output, which is less prone to zero or negative values than gross value added. Our focus on gross value added is intended to better mirror economy wide measures of labor productivity, which are based on GDP or GVA.

[9] According to OECD STAN Indicators the manufacturing sector accounted for less than 15% of value added in France, Canada, the US and UK, for a fifth of value added in Italy and Japan, and a quarter of value added in Germany in 2007. With the exception of Canada the relative size of the manufacturing sector in these economies shrank by 20-50% in the 25 years to 2007.

Here we briefly outline key features of the ARD that have implications for the analysis in this paper.

The ARD 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.[10] Data are available for 1997-2011 and for manufacturing back to 1974 and are collected for establishments (or rather, reporting units). We aggregate the data up to the enterprise level, as banking relationships are more likely to take place at this level than the plant or establishment levels.[11] Details of the ARD data can be found in Bovill (2012), Griffith (1999) and Harris (2005).

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) that is used as the sampling frame for most UK Census Bureau business surveys. The ARD includes basic information (e.g. industry, ownership structure, and indicative employment[12]) for all businesses in the sampling frame. In the sectors that we consider this population includes more than 1.5 million enterprises covering employment of just under 16 million, around 55% of the number employed in the British economy as a whole (Appendix Table A1). The population data allow us to determine business entry and exit, which cannot be calculated from the surveyed sample alone (Disney *et al.*, 2003) and, importantly, allows us to calculate grossing weights so that our decomposition analysis is representative of the macroeconomic phenomena that we seek to explain in terms of firms' behaviour.

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[10] 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.

[11] The enterprise level is the smallest legally independent unit in the data. We have also carried out analysis at the level of the establishment, e.g. as in Disney *et al.* (2003) and Barnett *et al.* (2014). The results of this analysis do not change our main conclusions. In normal times, the within establishment component accounts for a smaller proportion of overall productivity growth than the within enterprise component, as one might expect (some of the productivity contributions from external reallocation across establishments occurs within enterprises). But, in terms of explaining the productivity deviation from trend after the financial crisis, it is the within component that accounts for the vast majority of this gap whether calculated at the enterprise or establishment level.

[12] 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. For those years where we are able to make the comparison this indicative employment measure corresponds very closely with the point in time measure of employment that we observe for surveyed businesses, except in the earlier years of the survey where there is some discrepancy. We exclude years before 2001 because of these discrepancies and because of an unexplained shift in the size distribution of the business universe between 2000 and 2001.

In grossing up the data we take into account key aspects of the underlying stratification of the annual sample.[13] 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 (survivors), those that exist at time *t-k* but not at time *t* (exits) and those that exist at time *t*, but not at time *t-k* (entry). In carrying out the decompositions we weight up the data separately for each of these three categories of firm. 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 only one of these time periods. In other words, the sampling probability (in the longitudinal sample) is much smaller for continuers than for either entrants or exitors, 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, as shown in the next section and as is widely recognized, surviving firms tend to differ substantially from entrants and exitors. This 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 equations (1) through (5).[14]

Sampling probabilities in the ARD vary by size of firm. In particular, the probability of observing in the survey a specific micro business (a business employing less than 10 employees) in a specific year is just 1%. As a result, the probability of observing a micro business in two separate years (conditional on being live) is only 1 in 10,000.[15] This is illustrated in Appendix Table A2, where we show the number of observations in the survey for exiting and continuing enterprises (survival status evaluated over 4 years) by size of enterprise.[16] Typically we observe only 60 continuing micro firms, which represents 0.01% of the population of continuing micro firms. As shown in table A1 micro businesses account for a sizable share of economic activity in Britain: micro businesses account for 20% of employed

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[13] 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 aggregating industry groups and then recalculating.

[14] The grossed versions of equations (1) through (5) are shown in Appendix B.

[15] This applies when there is a minimum of three years between surveys. When there are three years or less between survey years the longitudinal sampling probability should be closer to zero. This is because once selected for the survey in year *t* a micro firm cannot be selected for a repeat survey before year *t+4* unless it changes size category. These (Osmotherly) rules are intended to reduce the burden on small businesses (Bovill, 2012).

[16] 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 in Table A2, where there are 3 years gaps between survey years; except in the case of micro businesses, see previous footnote. In theory firms are not re-sampled for at least two years after appearing in the sample, therefore longitudinal sampling probabilities may be smaller 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 enterprises, in part due to non-response and due to smaller establishments (that are part of the enterprise) not being sampled.

persons in the sectors we consider. But, the longitudinal sample is insufficient to support representative analysis of this group of firms and therefore we drop them from our decomposition analysis and focus on the sample of firms with 10 or more employees.[17] In the next section we show how the exclusion of micro firms affects the aggregate patterns we explain. In the following analysis we define live enterprises as having 10 employees or more and adjust our definitions of survival, entry and exit as accordingly; entry is not recorded until a firm reaches the 10 employee threshold and exit is recorded as soon as a firm's employment falls below 10.[18]

The ARD financial information is published in current values. GVA deflators published by the UK Census Bureau are used to construct real values; these are available at the 2- and sometimes the 3-digit sector level.[19]

## 4.2     *Trends in productivity and business churn*

UK GDP shrank in 2008 and 2009 following the global financial crisis that started in 2007. During this recession labor productivity fell, so that by 2009 whole economy labor productivity was 5% below its peak in 2007.[20] This is a typical cyclical response, but three years later in 2012 labor productivity was still 4% below its 2007 peak, and 15% below its pre-crisis trend, and it is this stagnation that is of particular interest because it raises the question whether the supply capacity of the economy was harmed by financial factors that caused a misallocation of resources. Figure 1 illustrates the development of labor productivity over this period in the market sectors that we look at. We show 3 separate series. One is based on the grossing up of the ARD microdata that we use in our decomposition analysis and is shown alongside a productivity profile that can be generated from sector data published by the UK Census Bureau that are based on the same business surveys (ABI & ABS series in Figure 1). Both of these series illustrate a stagnation in market sector labor productivity in the aftermath of the credit crisis,

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[17] An alternative approach is to include micro firms and ignore the stratification of the (continuer) sample by micro and other small businesses. This essentially makes the (unlikely) assumption that the productivity performance, and changes in this performance, of the substantial number of micro businesses in the population is much the same as that of other small businesses.

[18] It is not always clear how previous decomposition analyses using the ARD or similar surveys deal with the weighting issues discussed here and the issues surrounding micro firms.

[19] There are a couple of important changes in the ARD data over the sample period that we analyse. From 1997 to 2008 the ARD includes the ABI-1 (Annual Business Inquiry-1), a survey of employment, and the ABI-2 (Annual Business Inquiry-2), a survey of financial information. In 2009 the ABI-2 was replaced by the ABS and the ABI-1 was replaced by BRES. This introduces some discontinuities in the data, which we minimise by grossing the data to the underlying sampling frame, which did not change. Also, 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 continuity in the sectors that we analyse this requires us to drop a few 3-digit sectors.

[20] Measured using ONS series LNNN "Output per filled job: Whole economy". The output measure in this series is gross value added.

with productivity levels in 2011 around 1-3% below 2007 levels, much as for the economy as a whole. We also show a labor productivity series for the entire market sector, published by the UK Census Bureau, which tracks quite closely the ABI & ABS series in Figure 1 and illustrates that labor productivity did not get any better in 2012.

As shown in Figure 1 the labor productivity profile that is based on our decomposition sample differs from the series based on published data. Such differences are well-known (Franklin & Murphy, 2014) and to be expected because of small differences in sector and size coverage and, inevitably, our cleaning and weighting procedures differ from those undertaken by the UK Census Bureau.[21] In particular, the series constructed from our decomposition sample displays a steeper profile for labor productivity than the two series based on official statistics. But, as is encouraging, all these series exhibit broadly the same pattern over time, with labor productivity in 2011 a little more than 10 per cent below a simple linear extrapolation of the trend 2001-2007.

The ARD data records employment in terms of heads rather than hours. In the years following the financial crisis average hours worked fell, which means that labor productivity measured per head appeared weaker than measured per hour. But, the decline in average hours worked does not change much the overall picture of productivity stagnation presented in Figure 1. According to UK Labour Force Survey data[22] average hours worked fell by 1.7% between 2007 and 2011.[23] Measured per hour, rather than per job as in Figure 1, the ONS market sector series shows a drop in labor productivity 2007-2011 of 3.5% rather than 5%.

We study productivity changes over the 4-year period since the global financial crisis for which we have data, looking at productivity changes between 2007, just before the economy

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[21] We truncate the top and bottom 1% of the labor productivity distribution within 1-digit industry sectors in each annual survey. The sample of firms that we use for the decomposition analysis differs from this full ARD sample, because we drop 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*). As discussed in the previous section, this means that the sample used for the decomposition analysis is much smaller than the full sample. As a result it is more sensitive to individual outlying observations and, grossed up using the weighting strategy described in the previous section, will not necessarily produce similar trends in labor productivity to that which can be produced using the full sample. It is of course desirable that grossed to a population total the decomposition sample reflects broadly the same productivity trends apparent in the full dataset and other sources. To achieve this we make use of the longitudinal data to eliminate further outlying observations before grossing up the data. Specifically, we truncate the top and bottom 2.5% of the distribution across continuing firms of annual changes in labor productivity relative to base by sector and year.

Appendix Figure A1 shows the productivity profile generated by the full ARD sample for the case where we exclude micro firms, as in our decomposition sample and analysis, and when we include micro firms. Broadly speaking the exclusion of micro firms does not alter the productivity profile significantly. However, productivity in 2011 measured relative to its previous peak is lower using the series that includes micro firms. This is partly because this series displays a tick up in labor productivity in 2008 when the economy was shrinking, which does not match the official data.

[22] ONS (2011) *Hours worked in the Labour Market, 2011*, ONS Statistical Bulletin

[23] There is some variation across sectors. In the construction sector average hours worked fell by 3.8% between 2007 and 2011, which is more than in manufacturing and services.

went into recession, and 2011, when the recession was over, but economic recovery was very much muted. We compare this to productivity changes over previous 4-year periods. Although business churn is relatively small when measured on an annual basis, we also decompose annual productivity before and after the credit crunch, which allows us to examine trends over time in short-term productivity dynamics.

Figures 2 and 3 illustrate business entry and exit rates, respectively, implied by the data we use. We show these for all firms and for the measure of entry and exit that we use in our decomposition analysis, where we classify businesses as live when they have 10 or more persons employed. At any one point in time, more than a third of live businesses will have entered the market over the previous 4 years and more than a third will die over the following 4 years. Entry, in particular, and exit rates are higher when we include micro firms, reflecting the fact that most businesses enter when they are relatively small and that death rates are higher for smaller businesses. Measured on an annual basis business churn is significantly less and here there is not much difference in magnitude between the two measures that we use.

Consistent with data published elsewhere[24] we observe a dip in annual entry rates in 2009 and 2010 of around 2 percentage points, suggesting that it became more difficult or less worthwhile to enter the market after the credit crunch. This drop is more evident in the 4-year entry rate after 2008, which to some extent reflects cumulated changes in annual entry rates. In Figure 3 we see 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; again consistent with published data. When we include micro firms we also see a rise in 4-year exit rates after 2004, when surviving 4 years into the future meant surviving the global financial crisis. Nevertheless, this increase in exit rates might be regarded as relatively insignificant seen against the backdrop of a fall in GDP of 6%. It also obscures the underlying downward trend over the period in the share of employment accounted for by exiting firms (not shown), which was only briefly interrupted during the recession. This downward trend in the employment share of business exits, despite a relatively stable business exit rate, reflects a change in the size composition of the population of firms towards smaller businesses, which typically have higher exit rates than larger businesses, as well as a gradual decline in the exit rate for medium and large size firms. It is for these reasons that increases in the probability of exit are only apparent in the data including micro firms, suggesting that it was primarily these very small businesses that found it more difficult to survive after the credit crunch. It is this absence of a more substantial increase in business deaths that has led to concerns that bank forbearance may be propping up businesses that would otherwise have died (Arrowsmith *et al.*, 2013).

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[24] ONS (2013) *Business Demography, 2012*, ONS Statistical Bulletin

How business churn affects productivity depends of course on the relative productivity performance of businesses that enter and leave the market and of surviving firms. Labor productivity for these groups of firms are shown in Figures 4 and 5, where survival status is evaluated over 1 and 4 year gaps respectively. As is evident there, it is the low productivity firms that exit. On average firms that will die in the following year are 21% less productive than firms that survive. Firms that will die over the following 4 years are 17% less productive than firms that survive within this time frame. Labor productivity amongst entrants is 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, which implies that net entry (entry less exit) boosts productivity, as is typically found in the literature. On average over the sample, firms that have entered the market in the last year are 13% less productive than incumbents. Entrants in the previous 4 years are 11% less productive than businesses that are more than 4 years old.

What Figures 4 and 5 also illustrate is that the labor productivity of both entrants and dying firms fell compared to that of continuing firms after the global financial crisis; by 2 percentage points on average when survival status is measured over a year. The drop in the relative "quality" of entrants is consistent with a situation where a lack of bank finance has made it increasingly difficult to enter the market as a capital intensive business.[25] We might also have expected to see the opposite effect, e.g. if banks became more selective in financing entrants. The direct effect of bank forbearance on the "quality" of exitors relative to those that survive may 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 to survivors, which is what we observe in the data.

## 5      RESULTS

### 5.1      *Productivity dynamics in the wake of financial crisis*

The effects on labor productivity growth of external restructuring, be this through changes in market shares or business entry and exit, is assessed by decomposing productivity growth as described in section 3. Table 1 shows the contributions to the change in aggregate productivity between 2007 and 2011 of business entry, exit, the reallocation of market shares between stayers, and productivity changes within enterprises. We discuss these contributions as measured by our preferred decomposition method, described by equation (2), shown in the

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[25] Note that Barnett *et al.* (2014), chart 16, find a different time profile for the relative productivity of new versus incumbent firms. They find a very marked increase in entrants' productivity after 2004, which eliminates the productivity gap between entrants and survivors.

first panel of the Table 1. We also decompose productivity changes over 4-year periods before the recession and show what this implies about the productivity growth *change* after the credit crisis, a measure of the productivity gap relative to trend. We compare results using different decomposition methods (also shown in Table 1) in the next section.[26]

Looking at the first panel in Table 1 the weakness of productivity growth since 2007 appears to be accounted for primarily by a sharp drop in productivity within enterprises, which was not quite off-set by the productivity enhancing effects of external restructuring. On our preferred decomposition method, the within component subtracted 10.1 percentage points from productivity growth 2007-2011. Reallocation of market shares between continuing firms added 6.5 percentage points to productivity growth and the effect of net entry was to add another 2.4 percentage points, leaving labor productivity in 2011 1.2% below where it was in 2007.

How do the underlying sources of aggregate productivity change 2007-2011 compare with the 4 years before the financial crisis? Between 2003 and 2007 labor productivity rose by 15.8 per cent. We estimate that more than half this increase (56% on our preferred decomposition method) was due to increases in productivity within continuing firms. External restructuring accounted for the rest of the productivity increase, adding 6.9 percentage points to productivity growth. Table 1 also shows the difference between productivity growth 2007-2011 and 2003-2007. Based on this comparison labor productivity in 2011 appeared to be around 17 per cent below the level it would have been had it continued to grow as it did 2003-2007. This reduction in productivity relative to trend is (more than) accounted for by the reduction in productivity growth within continuing businesses, rather than by a collapse in the productivity contribution of external restructuring. In other words, the Great Stagnation does not appear to have come about by a reduction in the efficiency of resource allocation, driven e.g. by an adverse credit supply shock. On our preferred decomposition there is a 2 percentage point *increase* in the contribution of external restructuring between 2003-2007 and 2007-2011. The productivity growth contribution of exiting firms is a little higher 2007-2011 (4.5 percentage points) than in 2003-2007 (3.7 percentage points). This is despite the reduction in job destruction due to firm exit, which fell from 20% to 16% of employment amongst the firms we study, and reflects the increased productivity differential between continuing and exiting firms during the Great Stagnation illustrated in Figure 5. This increased productivity differential

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[26] The aggregate market sector results in this paper are obtained by applying the decomposition equations (2)-(5) to the aggregate market sector. We have also calculated results where we apply the decomposition equations to 1-digit industries within the market sector and then average across these industries using industry employment shares. The results obtained in this manner are very similar to those reported in this paper.

may in part reflect forbearance of the "best of the worst", which will limit the extent to which the effects of forbearance are picked up in the exit component.

We can also compare the sources of productivity growth 2007-2011 to the same 2001-2005.[27] Between 2001 and 2005 productivity growth in the sectors we focus on was weaker than over the period 2003-2007. The figures in Table 1 suggest much of this was because the productivity contribution of external restructuring was less in 2001-2005 than in 2003-2007. Therefore, when benchmarking developments 2007-2011 against 2001-2005 we find that the reduction in productivity relative to trend would have been much worse were it not for the sizable *increase* in the contribution of external restructuring to aggregate productivity performance after the credit crunch. The reduction in the within component of 15.7 percentage points is partially offset by an increase in the external restructuring component of around 7 percentage points, so that the "productivity gap" is only 8.7%. Again, these numbers do not suggest that a reduction in the efficiency of resource allocation is to blame for the productivity weakness observed since the credit crunch. The comparison against 2001-2005 does suggest that entering firms detracted more from productivity growth 2007-2011 than might have been expected based on historical experience.

In Table 2 we report these 4-year productivity growth decompositions for sub-groups of firms: manufacturing and services, SMEs and larger businesses (firms are distinguished by group at time *t-k*). The distinction between manufacturing and services is relevant because the vast majority of the related literature considers manufacturing only, despite its small size compared to the service sector. In the context of this paper there is the additional interest in the manufacturing sector in that it is more capital intensive than services, and therefore, arguably more sensitive to financing constraints (this is also borne out in Table 3 where we rank industries according to their bank dependence; we return to this later). The distinction between SMEs and larger firms is important because larger firms can typically access alternative forms of finance to bank finance and SMEs cannot.

There are several points worth noting here. First, in both manufacturing and services the within component more than fully accounts for the decline in labor productivity following the financial crisis relative to its pre-crisis trend. The same holds true for both SMEs and large firms. This points to a relatively broad based (across key groups of firm) shock to labor productivity within firms as a key driver of productivity weakness, rather than inefficiencies in resource allocation. Consistent with what we might expect in a banking crisis, it is interesting to observe that this adverse shock was larger in magnitude amongst SMEs, which tend to be more dependent on banks than larger firms, and amongst manufacturing firms, which, on average, tend to be more dependent on banks than service sector firms. Second, although it is fair to say

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[27] As discussed in the data section we exclude years before 2001.

that it was not a drop in the contribution to productivity of external restructuring that lies at the heart of observed productivity weakness, indeed in Table 2 this contribution increases relative to trend for almost all sub-groups and time periods shown for comparison, this contribution clearly was not sufficiently strong to offset the sharp decline in the within component. The question is how much of an offset did we expect? We return to this point in subsequent sections, but for now we note that the extent of this offset depends very much on the time period used for comparison. We also note that the offset from the rise in the contribution of external restructuring was more important for SMEs than for large companies, again making it difficult to conclude that inefficiencies in resource reallocation are to blame for productivity weakness. But the picture is unclear. The offset to productivity decline within firms from the rise in the contribution of external restructuring was smaller in the manufacturing than the services sector, at least when comparison is made against the period 2001-2005. In light of the relative bank dependence and capital intensity of production in this sector this might be interpreted as evidence that the productivity contribution of external restructuring was indeed hampered by the credit crisis.

So, on the basis of these 4-year productivity growth comparisons, what can we say about the likely impact of the credit crisis on aggregate productivity growth via its impact on allocative efficiency across firms? First, it is not obvious that the shock to credit supply, which companies undoubtedly have faced, has led to a substantial drag on aggregate productivity growth by hindering effective resource allocation. The drop in productivity within firms accounts for the majority of the decline in overall productivity relative to trend and is broad based: across manufacturing and services and across different size firms. Second, the evidence is consistent with the idea that the banking crisis may have made it more difficult for entering firms to raise funds for investment, reducing the labor productivity of entering relative to incumbent firms. The entry component accounts for around ½ to 1½ percentage points of the productivity gap (Table 1, first panel). Third, the precise conclusions one might draw regarding the importance of inefficiencies in resource allocation depend on what is regarded as a suitable counterfactual contribution for the external restructuring component. We suggest the time period used for benchmarking is likely to be quite important.

Figure 6 shows how annual labor productivity growth is accounted for by within enterprise changes in productivity and by external restructuring. Much as the decompositions of 4-year changes in productivity in Table 1, these suggest that the weakness of productivity growth since the credit crunch has been associated with a broad-based decline in productivity within firms. On average, the contribution of external restructuring is the same over the period 2002-2007 and during the Great Stagnation. However, Figure 1 also illustrates that since the credit crunch the contribution of external restructuring to productivity growth has gradually

shrunk. It is the between firm reallocation component that is responsible for this downward trend, which, were it to continue, would provide stronger evidence that the contraction of bank lending has led to inefficiencies in resource allocation that have harmed aggregate supply capacity.

*5.2      Decomposition methods compared*

So far our discussion has focused on the sources of productivity growth as described by the decomposition that we propose in equation (2). How do these results compare to those obtained using existing decomposition methods in the literature (also shown in Table 1)?

Looking at productivity growth 2007-2011, the drag on productivity growth that occurs because of a drop in productivity, on average, within firms varies between 3.5% (FHK) and 14.7% (MP). While this variation is quite substantial, there is more concurrence between decomposition methods when the drop in productivity due to the within component is measured relative to its pre-crisis trend. All methods suggest that the overwhelming majority of the productivity gap can be attributed to a reduction in productivity within firms. With the exception of the case where the productivity gap is evaluated against trend 2003-2007 and the decomposition method is GR or FHK, the within effect more than accounts for the productivity gap, which implies that there was some offset to the within effect from an increase in external restructuring. The magnitude of this offset (or lack of offset) from the productivity effects of reallocation depends on the decomposition method used. Our combined decomposition and the MP decomposition suggests it reduced the productivity gap (measured relative to trend 2003-2007) by around 2 and 5½ percentage points respectively. In contrast, the GR decomposition suggests the contribution of external restructuring fell by 0.9 percentage points, due to a reduction in the contribution of net entry of 2.3 percentage points (also apparent using FHK; 1.6 percentage points), which is not apparent on either the MP or on our preferred decomposition. As discussed in section 3, this reduction is unlikely to reflect anything other than the fact that average productivity growth fell over this period. The reduction in the productivity gap due to a rise in external restructuring is particularly large when calculated using the MP decomposition. This is because the MP decomposition attaches equal weight to small and large firms when measuring the within and between contributions of continuing firms and these effects are greater in magnitude for SMEs than for large firms (see Table 2).

To summarise, all decomposition methods point to the importance of understanding within firm reductions in productivity when seeking to explain the general weakness of labor productivity in the wake of the financial crisis. But, they differ in gauging to what extent the weakness of the contribution from external restructuring matters in this context. The increase in the contribution of external restructuring is suppressed in the GR and FHK decompositions,

for the reasons discussed in section 3, and is particularly large in the MP decomposition, because of the significant weight attached to small firms.

This latter feature of the MP decomposition does in some instances lead to greater variation in the continuer components, across time periods and samples. In Figure 6 labor productivity growth contributions are reported using our preferred decomposition method in equation (2). However, we have undertaken these using also the FHK, GR and MP decompositions. With the exception of the MP decomposition these all suggest much the same about the stagnation in productivity growth since the financial crisis, i.e. that it was associated primarily with a sharp reduction in productivity within companies, rather than any obvious drag on growth from inefficient resource reallocation, eventhough the annual productivity contribution of external restructuring has trended downwards since 2007. The MP decomposition (not shown) would instead suggest that approximately half the more than 3 percentage point drop in average annual labor productivity growth between 2002-2007 and 2008-2011 was due to a reduction in the productivity contribution of market share changes between continuing firms. This is in contrast to the other decompositions, which suggest that all the change in average annual productivity growth since 2007 is accounted for by a drop in within enterprise productivity. It is also in contrast to the MP decomposition of 4-year productivity changes, which suggest that the productivity contribution of market share changes between survivors *increased* since 2007. Although it is possible for the 1-year and 4-year decompositions to lead to different conclusions, e.g. because 1-year survival is not the same as 4-year survival, as discussed in section 3 it is also the case that the between and within components in the MP decomposition are more sensitive to the influence of small firms in our sample. This is because they attach equal weight to each continuing firm regardless of market share. This sensitivity to the behaviour of individual small firms is exacerbated in our sample because of the large grossing weights attached to smaller firms.

*5.3    Recessions compared*

The labor productivity decompositions presented so far suggest that if anything the Great 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 drop 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. 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

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productivity changes (see discussion below). To get a better handle on what would have been the counterfactual contribution of external restructuring if the recession had not been instigated by a global financial crisis and credit crunch we compare productivity dynamics in the recent recession to that 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 (by 11% 1989-1992 and 9% 2007-2010 based on the firms in our sample). But, in the earlier recession, labor productivity rose on average during the years that output contracted, in stark contrast to recent experience.

Figure 7 shows how annual labor 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, shown in Figure 6. The slowdown in manufacturing productivity growth 2008-2010 arises very much because of a slowdown in productivity growth within firms.[28] The contribution to productivity growth from external restructuring over this period is similar to the pre-crisis years. Figure 8 illustrates labor productivity growth in the manufacturing sector before and after the recession of 1990. Then productivity growth slowed down before the recession hit, the drop in productivity growth was less marked than during the Great Recession, and productivity growth recovered to pre-recession rates more quickly. Despite these differences, it is apparent that during the 1980s and early 1990s it was also the within component that drove changes in productivity growth over time, much as in the 2000s. This comparison suggests that the cleansing effects of recession we observe post 2007 are much as we might have expected in a normal recession and does not point to resource inefficiencies as a key mechanism through which the financial crisis affected productivity.

Having said this, there is a difference between the two recessions that is consistent with the contraction of bank lending leading to greater inefficiencies in resource allocation in the latter recession. In both recessions changes in the contribution of external restructuring to annual labor productivity growth are relatively small in comparison to changes in the within component. But, it is interesting to note that after the recession in 1990 the contribution of

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[28] The same can be said about the slowdown 2008-2011. Here we show the data to 2010 for straightforward comparison to the data we have for the 1990 recession. There we have data for three 'crisis' years (1990-1992). After 1992 changes in the industry classification system and business reference numbers complicates comparison.

restructuring was slightly higher (or no less) than before. This is in contrast to the recession of 2008 after which the contribution from restructuring fell back a bit.

We can also look to other evidence on "normal" recessions for a benchmark against which to compare recent experience, although much of this concerns manufacturing. There is a large body of evidence that suggests that 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.[29] We know that in this respect the Great Recession and ensuing Stagnation was different. Gross job reallocation in the private sector was less over the period 2008-2011 than 2004-2007 (Butcher & Bursnall, 2013).[30] 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. 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. 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. Within plant shifts were pro-cyclical. They find a correlation between annual output growth and the between (within) components of -0.31 (0.63). This is similar to our findings for UK manufacturing 1985-1992, where the equivalent correlations based on the same decomposition method were -0.36 and 0.76 for the between and within components respectively.[31] But, this is different to our findings for UK manufacturing 2003-2010 where the productivity contribution of external restructuring was pro-cyclical (correlation with manufacturing output growth of 0.51). The within component was pro-cyclical as before (correlation with manufacturing output growth of 0.94).

These comparisons provide some suggestion 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 might have been expected on the basis of historical experience. This is consistent with the findings of Foster, Grim & Haltiwanger (2013), using a different methodology for US manufacturing, and with the conclusions of Barnett *et al.* (2014) that the banking crisis reduced the external restructuring component relative to the counterfactual of a normal recession. However, the main conclusion that emerges from this

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[29] See e.g. US 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.
[30] This appears consistent with the reduction in gross job reallocation associated with firm entry and exit during the post-crisis years in our data.
[31] Correlation calculated on the raw annual contributions rather than the 3-year moving averages shown in Figure 8.

comparison of recessions is that the recent recession was different to the previous recession because productivity growth collapsed within firms.

*5.4    External restructuring and productivity in bank dependent sectors*

We can gain further insight into the relationship between credit constraints, the efficiency of resource allocation, and aggregate productivity growth by examining how the productivity contributions of external restructuring have changed since the global financial crisis in sectors that are more or less bank dependent. We evaluate sectoral bank dependence by the proportion of businesses within a sector that have an outstanding bank charge. This information is obtained from accounting information on UK companies held in Companies House. All incorporated businesses are required to report whether there is a charge raised against them and if so whether it is held by a bank. Based on this measure Table 3 ranks sectors according to their bank dependence before the crisis. Measured in this way manufacturing companies in the UK appear more bank dependent than companies in other sectors. We have already discussed manufacturing in the section above. Construction companies also appear relatively bank dependent, as banks hold charges against 2 in 5 companies in the construction sector. But, we do not focus on the construction sector here because the exclusion of micro firms from the ARD sample impacts significantly on labor productivity trends in this sector. All the other sectors listed in Table 3 and included in our aggregated analysis above are service sectors. Of these, the Wholesale & Retail and Accommodation & Food sectors are the most bank dependent on our measure. In these sectors 40% of companies have an outstanding bank charge. In contrast, in the Professional & Scientific and Information & Communication sectors around 15% of companies have an outstanding bank charge. In the remaining service sectors in Table 3 between a fifth and a third of companies have a bank charge.

We group sectors into these 3 categories, distinguished by bank dependence, and calculate the contribution of external restructuring to annual labor productivity growth there. We focus on SMEs because these are more likely to be bank dependent. Amongst service sector SMEs all annual labor productivity growth (on average 2002-7) occurs due to external restructuring.[32] The within component is generally close to zero. In Figure 9 we illustrate the trend in the contribution of external restructuring to productivity growth amongst service sector SMEs. We show this for the three sector groups discussed above. On average 2004-2006 external restructuring contributed approximately 4 percentage points to annual productivity growth amongst SMEs in each of these sector groups. Following the global financial crisis this

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[32] Specifically, amongst service sector SMEs 2002-7 average annual labor productivity growth comes to 3.1% per annum, of which 3.9 %-points is due to external restructuring. Over this same period  average annual labor productivity growth for manufacturing SMEs comes to 4.0% per annum, of which 3.6 %-points is due to external restructuring.

contribution fell sharply in the bank dependent sector group so that by 2009-2011 this process contributed less than 1 percentage point to annual productivity growth in this group. The picture is very different for the least bank dependent group. Here the contribution of external restructuring to annual labor productivity growth was 1 percentage point higher in 2009-2011 compared to 2004-6, so that by 2009-2011 there was a 4 percentage point gap between the productivity growth contribution of external restructuring in the least and the most bank dependent sectors. In Figure 10 it is evident that these differences between more and less bank dependent sectors are driven by differences in the contributions of net entry. The other sector group, which are neither remarkable or unremarkable in terms of their bank dependence, also saw a decline in the productivity growth contribution associated with resource reallocation (Figure 9), but this did not fall as far as it did in the bank dependent sectors and does not look out of line with the magnitude of this component in the early 2000s.

Again these patterns in the data provide suggestive evidence that the banking sector crisis led to inefficiencies in the process of resource reallocation between firms, with adverse consequences for aggregate productivity performance. Indeed this helps us attribute to banking sector failure the downward trend in the contribution of external restructuring after the crisis to overall (non-banking) market sector productivity (see Figure 6), but in aggregate these effects are quite small.


## 6    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. In order to do this we decompose UK market sector labor 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 use a new decomposition method that is a hybrid of methods used previously in the literature. This hybrid 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 more robust to measurement error than available alternatives and retaining comparability between restructuring measured at the

intensive and extensive margins. 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 labor productivity between 2007 and 2011 was first and foremost the result of a broad-based decline in productivity within businesses, and not 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 did not fall compared to the years prior to the recession and increased in comparison to earlier years. In other words, the recession does appear to have had some "cleansing effect" or been associated with creative destruction. However, this has not been sufficient to offset fully the large drop in productivity within firms and the question of what has caused this productivity drop within firms remains.

To further probe the role of resource allocation in the wake of financial crisis we compare productivity dynamics in the manufacturing sector in two different recessions, those which began in 1990 and 2008. The first of these was not instigated by banking sector collapse, the latter was. In both cases output contracted sharply. Only in the recent crisis did productivity collapse, and, in comparison to the previous recession, this was due to a larger collapse in productivity within firms rather than productivity weakness associated with inefficient resource reallocation. However, we do find some patterns in the data that point to an empirical link between banking sector crises, resource allocation and aggregate productivity. Since the credit crunch the contribution of external restructuring to annual productivity growth has reduced, and we find that underlying this downward trend is a reduction in the productivity contribution of external restructuring amongst SMEs in the more bank dependent sectors. We also find that a reduction in the relative productivity of entering firms may account for a small part (1 percentage point) of the productivity gap; difficulties in accessing finance may have hindered investment amongst new firms.

The data that we use introduces some limitations to our analysis. In particular, we are unable to include micro businesses (defined as businesses with employment less than 10) in our analysis of the longitudinal data. We have highlighted differences in aggregate trends that result from the exclusion of these businesses. The stagnation in aggregate productivity is evident whether or not micro businesses are included. We also note that a static Olley-Pakes decomposition of sectoral labor productivity, which does not rely on longitudinal data and therefore can better include micro businesses, does not point to a reduction in the efficiency of resource allocation since the financial crisis (see Field & Franklin, 2013). Although this methodology is very different to that employed in this paper, these findings are nevertheless

consistent with the main findings in this paper, suggesting that the exclusion of micro businesses is not central to our conclusions.

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 collapse 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 probably 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.[33]  Also, credit constraints may have contributed to productivity weakness within 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 we observe that productivity growth has been weaker amongst credit constrained companies than amongst companies with less reliance on the banking sector.

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[33] For example, Crawford *et al.* (2013) find that the drop in labor 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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FIGURE 1        TRENDS IN LABOR PRODUCTIVITY, UK 2001-2012
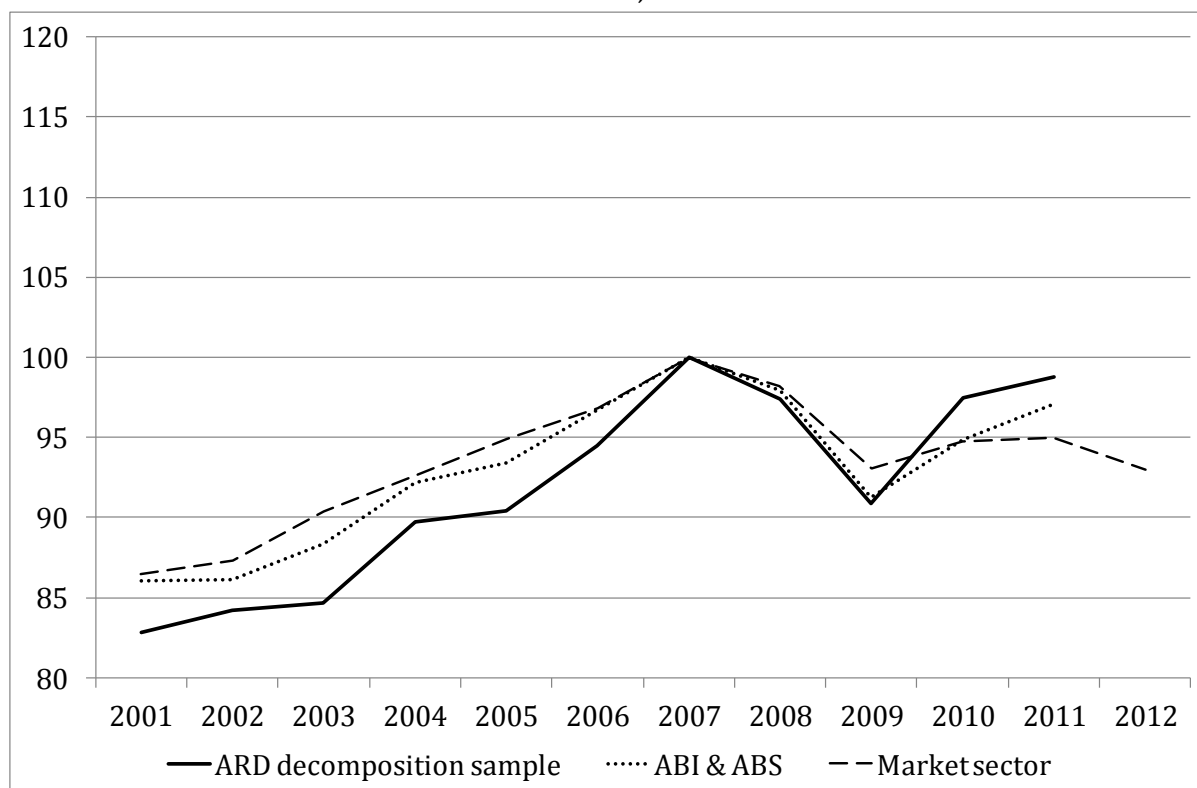


Source: ARD decomposition sample from Annual Respondents Database, ONS, and authors' calculations; ABI & ABS from Annual Business Inquiry and Annual Business Survey published sector data, ONS, GVA deflators, ONS, and authors' calculations; Market sector from *Labour Productivity, Q2 2013*, ONS, September 2013.
Notes: Labor 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.

FIGURE 2        BUSINESS ENTRY RATES
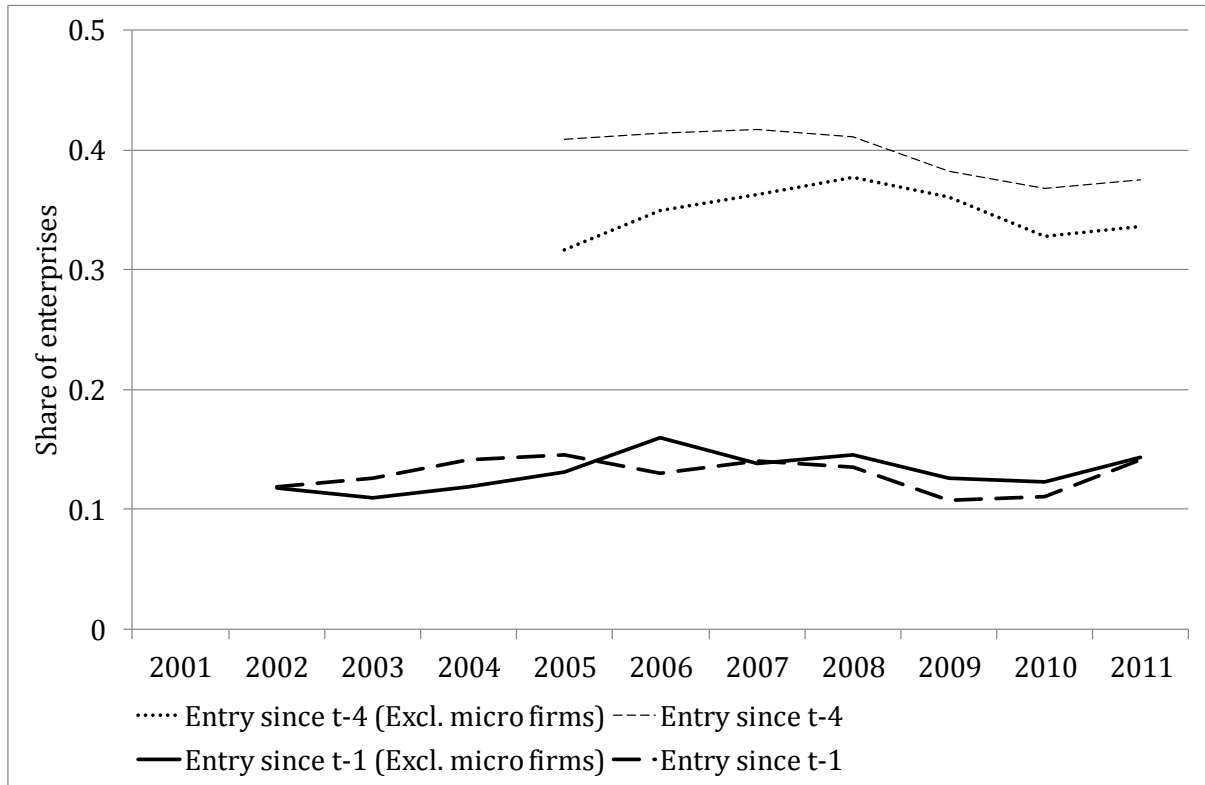


Source: Annual Respondents Database, ONS, and authors' calculations.

FIGURE 3        BUSINESS EXIT RATES
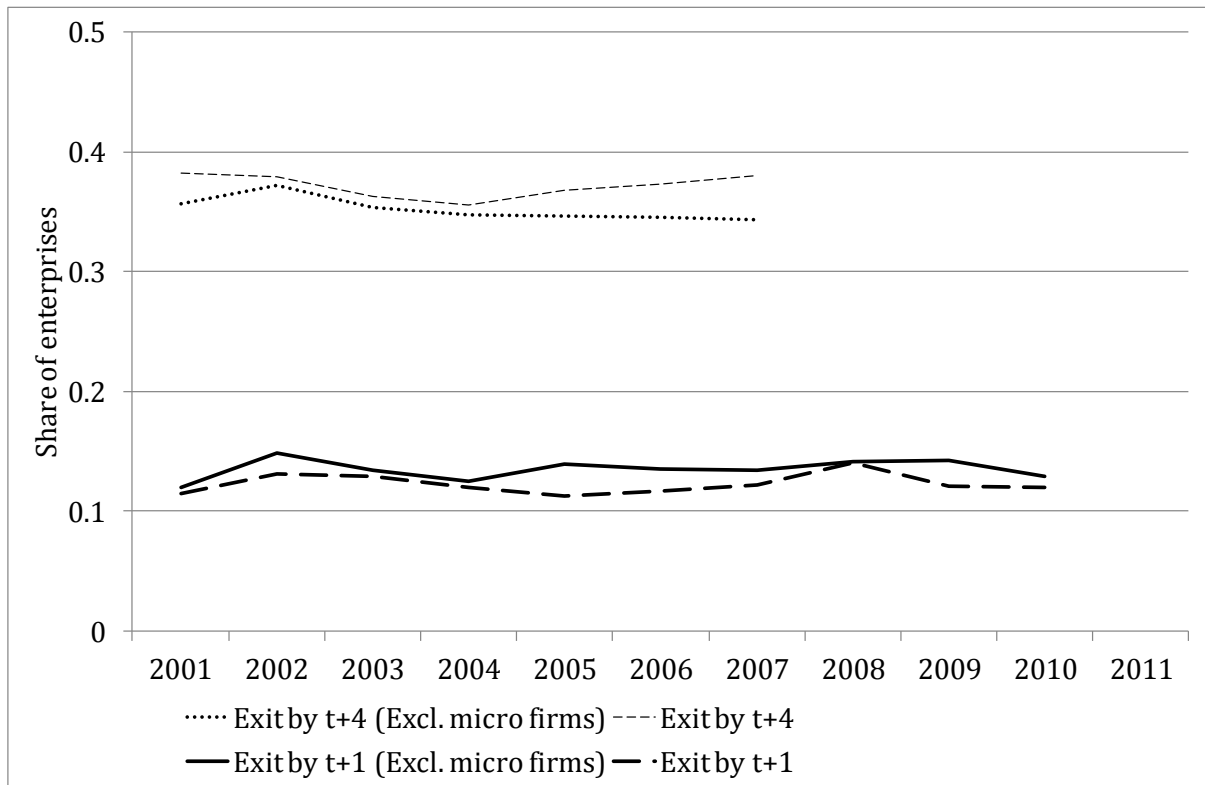


Source: Annual Respondents Database, ONS, and authors' calculations.

FIGURE 4      LABOR PRODUCTIVITY BY 1 YEAR SURVIVAL STATUS
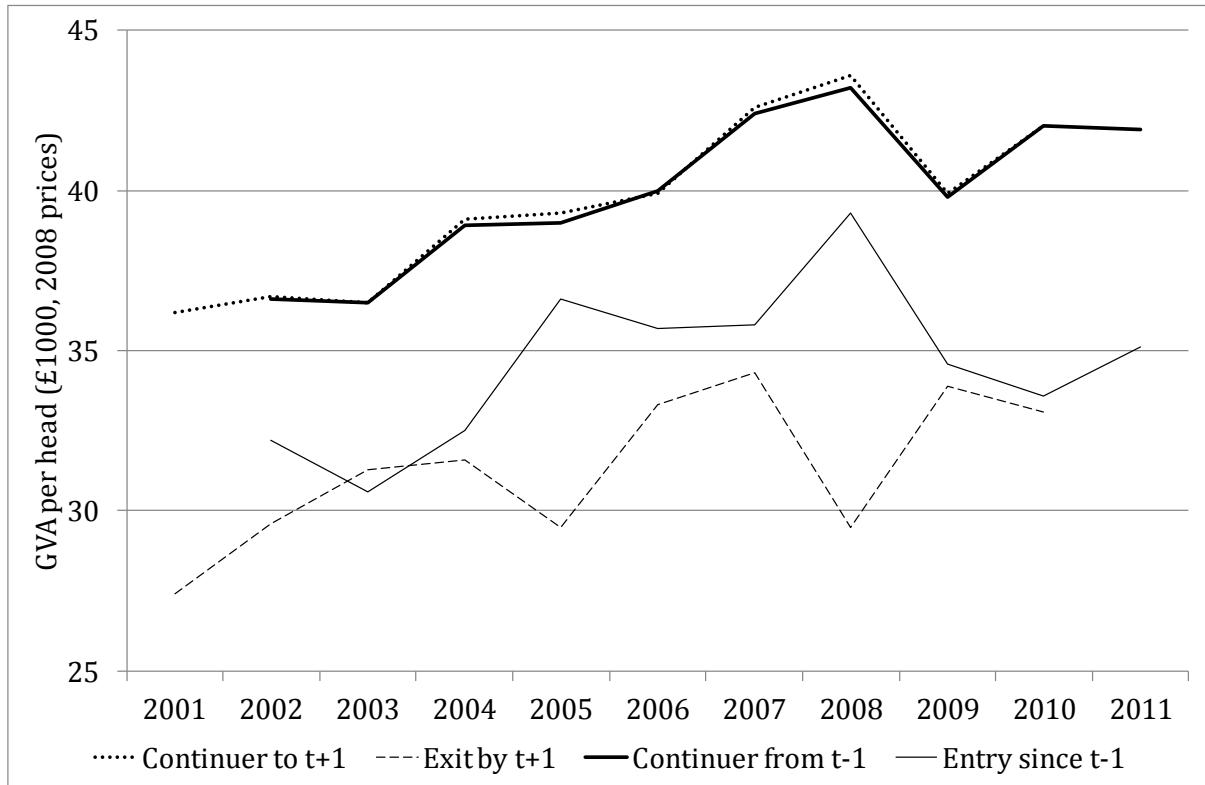


Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: Firms are classified as live if they are active and have 10 or more persons employed.

FIGURE 5      LABOR PRODUCTIVITY BY 4 YEAR SURVIVAL STATUS
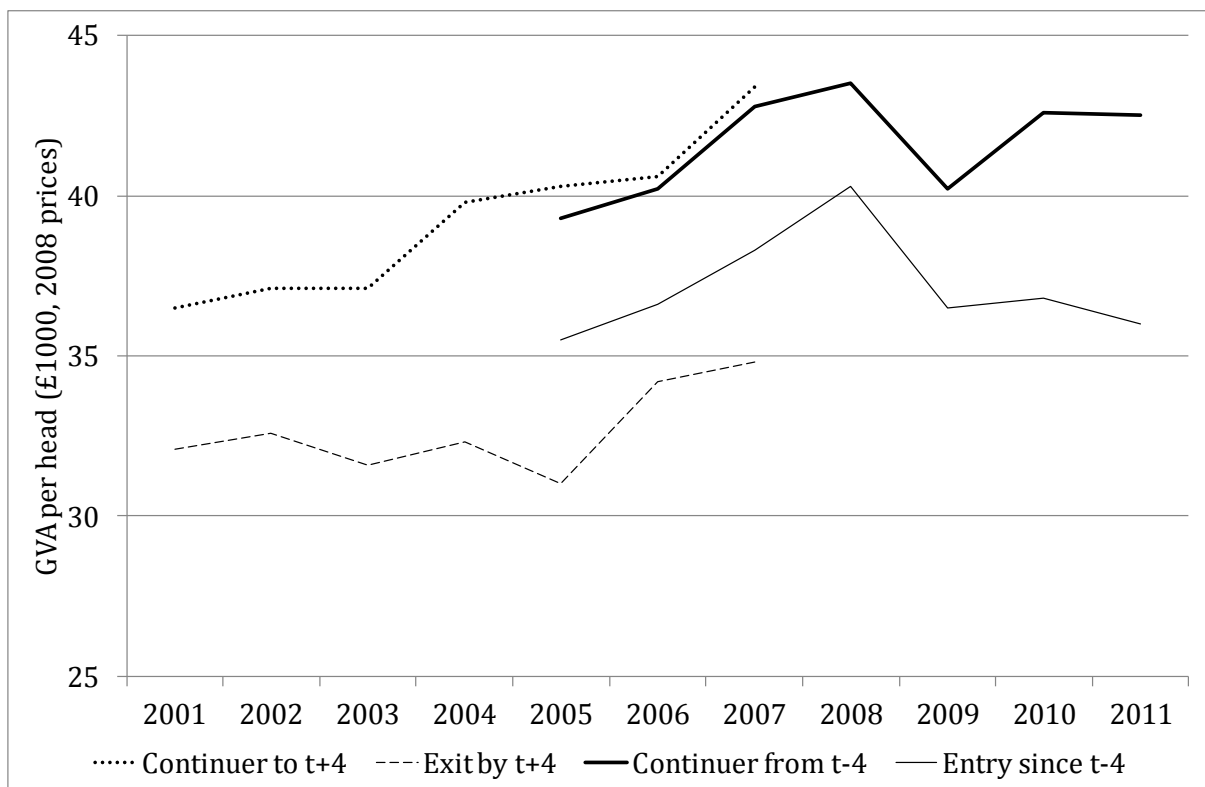


Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: Firms are classified as live if they are active and have 10 or more persons employed.

FIGURE 6          DECOMPOSITION OF 1-YEAR CHANGES IN LABOR PRODUCTIVITY
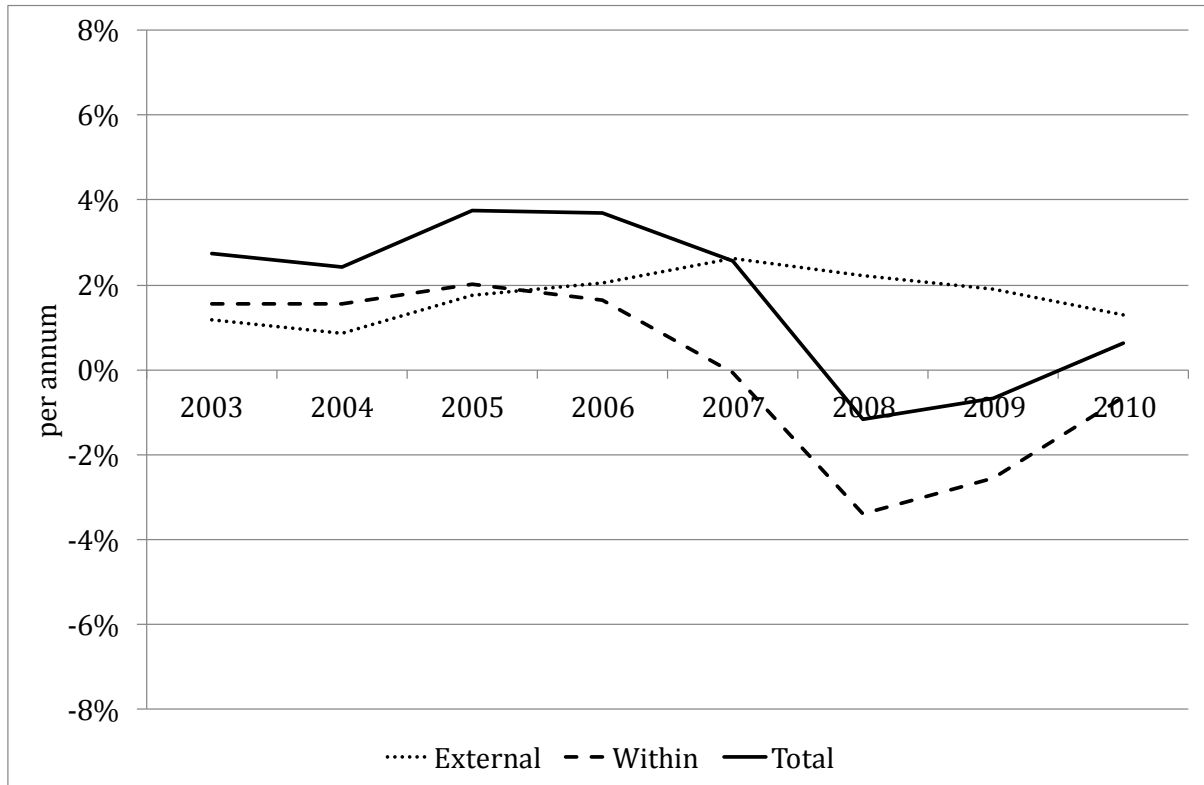


Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: HYBRID decomposition. Shown as a 3-year centred moving average. Non-farm non-financial market sectors excluding mining & quarrying, utilities and real estate activities. Britain. Firms are classified as live if they are active and have 10 or more persons employed.

FIGURE 7    DECOMPOSITION OF 1-YEAR CHANGES IN LABOR PRODUCTIVITY,
            MANUFACTURING, 2003-2010
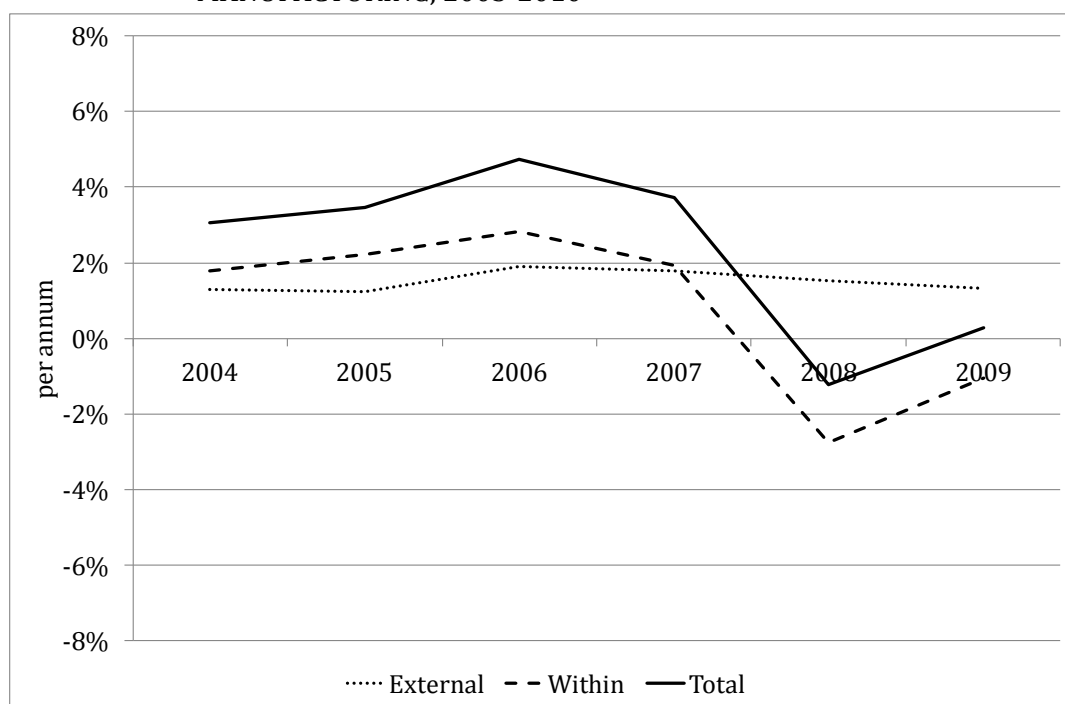


Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: HYBRID decomposition. Shown as a 3-year centred moving average. Britain. Firms are classified as live if they
are active and have 10 or more persons employed.
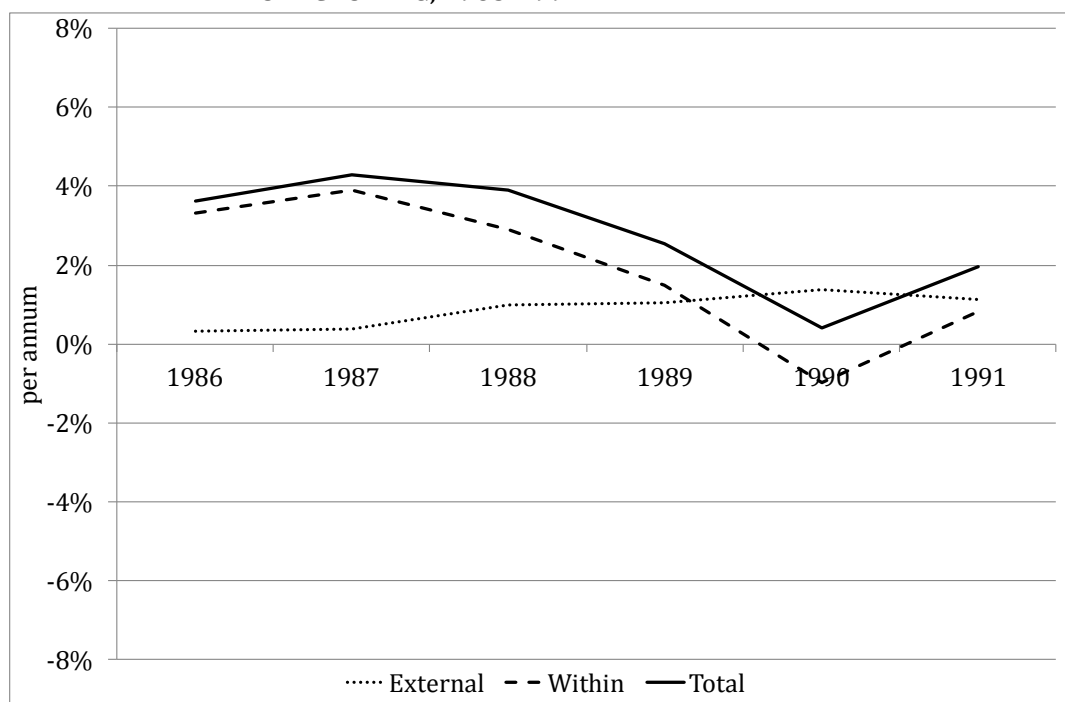

FIGURE 8    DECOMPOSITION OF 1-YEAR CHANGES IN LABOR PRODUCTIVITY,
            MANUFACTURING, 1985-1992



Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: See notes to Figure 7.

FIGURE 9     EXTERNAL RESTRUCTURING AND PRODUCTIVITY GROWTH,
             SERVICE SECTOR SMEs, 2002-2011
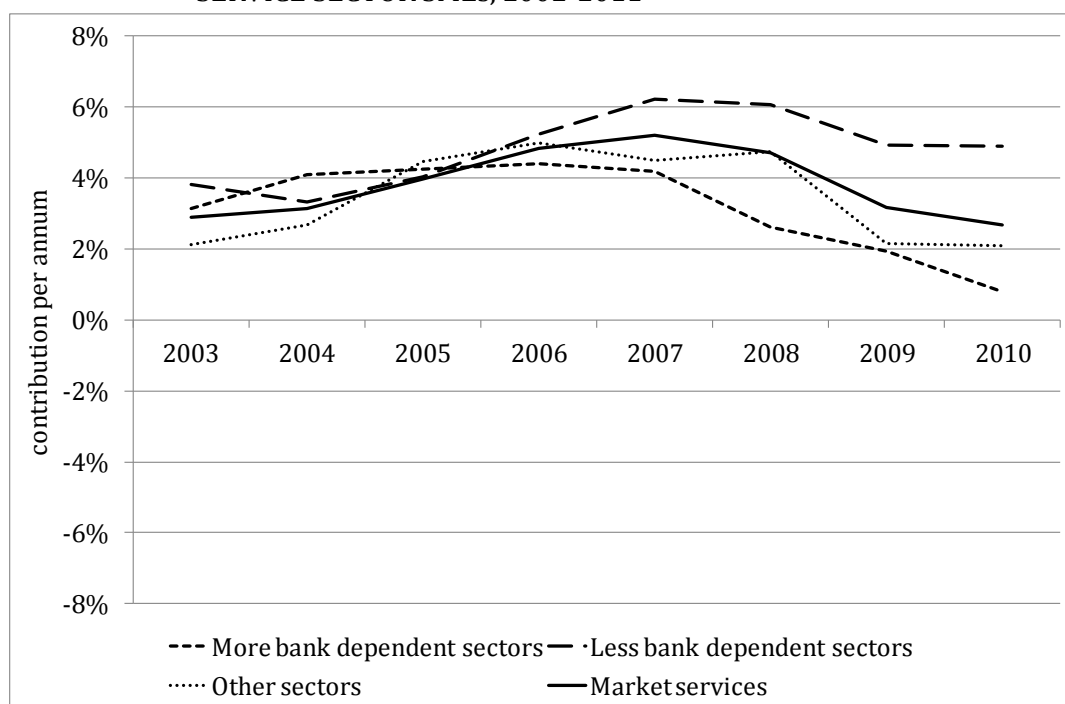


Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: HYBRID measure of the contribution of external restructuring to 1-year changes in labor productivity. Shown as a 3-year centred moving average. Britain. Firms are classified as live if they are active and have 10 or more persons employed. SMEs have no more than 249 persons employed. Bank dependent sectors include Accommodation & Food, Wholesale & Retail. Not bank dependent sectors include Information & Communication, Professional & Scientific. Other sectors include Transport, Administration & Support, Arts & Entertainment.

FIGURE 10     NET ENTRY AND PRODUCTIVITY GROWTH,
              SERVICE SECTOR SMEs, 2002-2011



Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: HYBRID measure of the contribution of net entry to 1-year changes in labor productivity. See notes to Figure 9.

TABLE 1        DECOMPOSITION OF 4-YEAR CHANGES IN LABOR PRODUCTIVITY

| Decomposition | | Growth components | | | | External | | | Employment shares | | Sample sizes (unweighted) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Within | Between | Entry | Exit | Net entry | Total | Total | Entrants | Exits | Continuers | Entrants | Exits |
| HYBRID | *Productivity growth(%)* | | | | | | | | | | | | |
| | 2007-2011 | -10.1 | 6.5 | -2.1 | 4.5 | 2.4 | 8.9 | -1.2 | 0.107 | 0.164 | 4897 | 3159 | 4308 |
| | 2003-2007 | 8.9 | 4.8 | -1.6 | 3.7 | 2.1 | 6.9 | 15.8 | 0.115 | 0.202 | 6885 | 4268 | 5704 |
| | 2001-2005 | 5.5 | 0.2 | -1.0 | 2.7 | 1.8 | 2.0 | 7.5 | 0.111 | 0.219 | 7348 | 4259 | 6338 |
| | *Productivity growth change (% points)* | | | | | | | | | | | | |
| | 2003-2007 to 2007-2011 | -19.0 | 1.7 | -0.5 | 0.8 | 0.3 | 2.0 | -17.0 | | | | | |
| | 2001-2005 to 2007-2011 | -15.7 | 6.3 | -1.1 | 1.8 | 0.7 | 7.0 | -8.7 | | | | | |
| MP | *Productivity growth(%)* | | | | | | | | | | | | |
| | 2007-2011 | -14.7 | 11.0 | -2.1 | 4.5 | 2.4 | 13.5 | -1.2 | | | | | |
| | 2003-2007 | 7.9 | 5.8 | -1.6 | 3.7 | 2.1 | 7.9 | 15.8 | | | | | |
| | 2001-2005 | 1.5 | 4.2 | -1.0 | 2.7 | 1.8 | 6.0 | 7.5 | | | | | |
| | *Productivity growth change (% points)* | | | | | | | | | | | | |
| | 2003-2007 to 2007-2011 | -22.5 | 5.2 | -0.5 | 0.8 | 0.3 | 5.5 | -17.0 | | | | | |
| | 2001-2005 to 2007-2011 | -16.2 | 6.8 | -1.1 | 1.8 | 0.7 | 7.5 | -8.7 | | | | | |
| GR | *Productivity growth(%)* | | | | | | | | | | | | |
| | 2007-2011 | -8.9 | 6.0 | -1.9 | 3.7 | 1.8 | 7.7 | -1.2 | | | | | |
| | 2003-2007 | 7.2 | 4.6 | -0.5 | 4.6 | 4.0 | 8.6 | 15.8 | | | | | |
| | 2001-2005 | 4.3 | 0.7 | -0.4 | 3.0 | 2.5 | 3.2 | 7.5 | | | | | |
| | *Productivity growth change (% points)* | | | | | | | | | | | | |
| | 2003-2007 to 2007-2011 | -16.1 | 1.4 | -1.4 | -0.9 | -2.3 | -0.9 | -17.0 | | | | | |
| | 2001-2005 to 2007-2011 | -13.2 | 5.2 | -1.5 | 0.7 | -0.8 | 4.5 | -8.7 | | | | | |
| FHK | *Productivity growth(%)* | | | | | | | | | | | | |
| | 2007-2011 | -3.5 | 0.5 | -2.0 | 3.8 | 1.8 | 2.3 | -1.2 | | | | | |
| | 2003-2007 | 12.8 | -0.3 | 0.4 | 3.0 | 3.4 | 3.0 | 15.8 | | | | | |
| | 2001-2005 | 9.7 | -4.3 | 0.0 | 2.1 | 2.1 | -2.2 | 7.5 | | | | | |
| | *Productivity growth change (% points)* | | | | | | | | | | | | |
| | 2003-2007 to 2007-2011 | -16.2 | 0.8 | -2.4 | 0.8 | -1.6 | -0.7 | -17.0 | | | | | |
| | 2001-2005 to 2007-2011 | -13.2 | 4.8 | -2.0 | 1.6 | -0.3 | 4.5 | -8.7 | | | | | |

Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: 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. Firms are classified as live if they are active and have 10 or more persons employed.

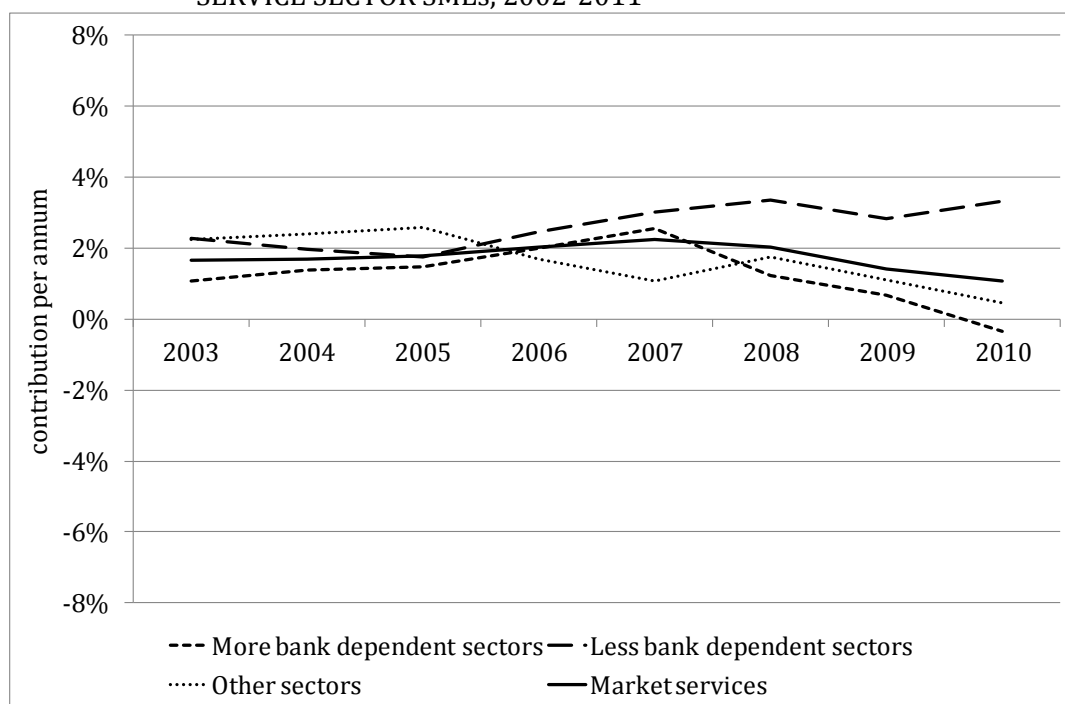TABLE 2          DECOMPOSITION OF 4-YEAR CHANGES IN LABOR PRODUCTIVITY FOR SUB-GROUPS OF FIRMS

| Sub-group | | Growth components | | | | External | | | Employment shares | | Sample sizes (unweighted) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Within | Between | Entry | Exit | Net entry | Total | Total | Entrants | Exits | Continuers | Entrants | Exits |
| Manufacturing | *Productivity growth(%)* | | | | | | | | | | | | |
| | 2007-2011 | -2.6 | 2.3 | -0.6 | 3.8 | 3.1 | 5.4 | 2.8 | 0.074 | 0.139 | 1747 | 433 | 1229 |
| | 2003-2007 | 23.3 | 1.5 | -1.6 | 4.3 | 2.7 | 4.2 | 27.5 | 0.073 | 0.224 | 2872 | 879 | 1744 |
| | 2001-2005 | 18.4 | 0.7 | -1.5 | 3.9 | 2.4 | 3.1 | 21.5 | 0.078 | 0.233 | 2766 | 828 | 1932 |
| | *Productivity growth change (% points)* | | | | | | | | | | | | |
| | 2003-2007 to 2007-2011 | -26.0 | 0.8 | 1.0 | -0.5 | 0.5 | 1.3 | -24.7 | | | | | |
| | 2001-2005 to 2007-2011 | -21.0 | 1.6 | 0.8 | -0.1 | 0.7 | 2.3 | -18.7 | | | | | |
| Services | *Productivity growth(%)* | | | | | | | | | | | | |
| | 2007-2011 | -12.0 | 8.8 | -2.4 | 4.8 | 2.4 | 11.2 | -0.8 | 0.112 | 0.162 | 2839 | 2357 | 2724 |
| | 2003-2007 | 5.2 | 7.3 | -1.6 | 3.8 | 2.2 | 9.5 | 14.7 | 0.12 | 0.191 | 3710 | 3048 | 3591 |
| | 2001-2005 | 3.6 | 1.0 | -0.7 | 2.5 | 1.8 | 2.8 | 6.4 | 0.118 | 0.211 | 4185 | 3084 | 3980 |
| | *Productivity growth change (% points)* | | | | | | | | | | | | |
| | 2003-2007 to 2007-2011 | -17.2 | 1.5 | -0.8 | 1.0 | 0.2 | 1.7 | -15.5 | | | | | |
| | 2001-2005 to 2007-2011 | -15.6 | 7.8 | -1.7 | 2.3 | 0.6 | 8.4 | -7.2 | | | | | |
| SMEs | *Productivity growth(%)* | | | | | | | | | | | | |
| | 2007-2011 | -20.7 | 13.0 | -4.2 | 10.7 | 6.5 | 19.5 | -1.2 | 0.177 | 0.262 | 2083 | 2836 | 3778 |
| | 2003-2007 | 0.9 | 10.3 | -3.4 | 9.0 | 5.5 | 15.9 | 16.8 | 0.19 | 0.285 | 4182 | 3983 | 4949 |
| | 2001-2005 | -3.8 | 5.2 | -1.5 | 5.3 | 3.7 | 8.9 | 5.1 | 0.184 | 0.292 | 4788 | 3984 | 5558 |
| | *Productivity growth change (% points)* | | | | | | | | | | | | |
| | 2003-2007 to 2007-2011 | -21.6 | 2.6 | -0.8 | 1.7 | 1.0 | 3.6 | -18.0 | | | | | |
| | 2001-2005 to 2007-2011 | -16.9 | 7.8 | -2.6 | 5.4 | 2.8 | 10.6 | -6.3 | | | | | |
| Large | *Productivity growth(%)* | | | | | | | | | | | | |
| | 2007-2011 | -1.8 | -1.5 | -1.4 | 1.8 | 0.4 | -1.1 | -2.9 | 0.049 | 0.098 | 2814 | 323 | 530 |
| | 2003-2007 | 14.5 | -0.6 | -0.9 | 1.0 | 0.2 | -0.4 | 14.1 | 0.052 | 0.147 | 2703 | 285 | 755 |
| | 2001-2005 | 11.6 | -2.9 | -0.1 | 1.2 | 1.1 | -1.9 | 9.7 | 0.049 | 0.169 | 2560 | 275 | 780 |
| | *Productivity growth change (% points)* | | | | | | | | | | | | |
| | 2003-2007 to 2007-2011 | -16.3 | -0.9 | -0.5 | 0.7 | 0.2 | -0.7 | -17.0 | | | | | |
| | 2001-2005 to 2007-2011 | -13.4 | 1.4 | -1.3 | 0.6 | -0.7 | 0.8 | -12.6 | | | | | |

Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: HYBRID 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. Firms are classified as live if they are active and have 10 or more persons employed.

TABLE 3        SECTORAL BANK DEPENDENCE

| Sector | Proportion of active non-financial businesses with a charge outstanding |
|---|---|
| Manufacturing | 0.48 |
| Construction | 0.39 |
| Wholesale & Retail | 0.39 |
| Accommodation & Food | 0.37 |
| Transport & Storage | 0.28 |
| Arts & Entertainment | 0.21 |
| Administration & Support | 0.21 |
| Professional & Scientific | 0.18 |
| Information & Communication | 0.13 |

Source: Financial Analysis Made Easy and authors' calculations.
Notes: Average 2005-2007. UK companies. The majority of chargeholders are identifiable banks.

APPENDIX A

TABLE A1      EMPLOYMENT AND NUMBER OF ENTERPRISES IN THE ARD POPULATION, BY SIZE OF ENTERPRISE

| | | Employment *(millions)* | No. of enterprises *(thousands)* |
|---|---|---|---|
| Enterprise size (numbers employed) | | | |
| Micro | (0-9) | 3.4 | 1393 |
| Small | (10-49) | 2.6 | 138 |
| Medium | (50-249) | 2.3 | 23 |
| Large | (250+) | 7.5 | 5 |

Source: ARD and authors' calculations
Notes: Average 2004-2011; Non-farm non-financial market sectors excluding mining & quarrying, utilities and real estate activities.

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

| | | | Employment | | No. of enterprises | |
|---|---|---|---|---|---|---|
| | | | *Sample count (thousands)* | *% of population* | *Sample count* | *% of population* |
| Enterprise size (numbers employed) and survival status | | | | | | |
| Micro | (0-9) | Exitors | 9.1 | 0.78 | 4106 | 0.77 |
| | | Continuers | 0.2 | 0.01 | 60 | 0.01 |
| Small | (10-49) | Exitors | 37.6 | 6.40 | 1735 | 5.44 |
| | | Continuers | 20.1 | 0.99 | 746 | 0.71 |
| Medium | (50-249) | Exitors | 112.5 | 25.65 | 1036 | 23.19 |
| | | Continuers | 222.6 | 12.30 | 1770 | 9.73 |
| Large | (250+) | Exitors | 588.2 | 68.77 | 550 | 61.41 |
| | | Continuers | 4568.6 | 69.52 | 2674 | 62.86 |

Source: ARD and authors' calculations
Notes: Average 2004-7; survivor/exit status evaluated over 4 years; Non-farm non-financial market sectors excluding mining & quarrying, utilities and real estate activities.

FIGURE A1      TRENDS IN LABOR PRODUCTIVITY, ARD ANNNUAL CROSS-SECTIONS
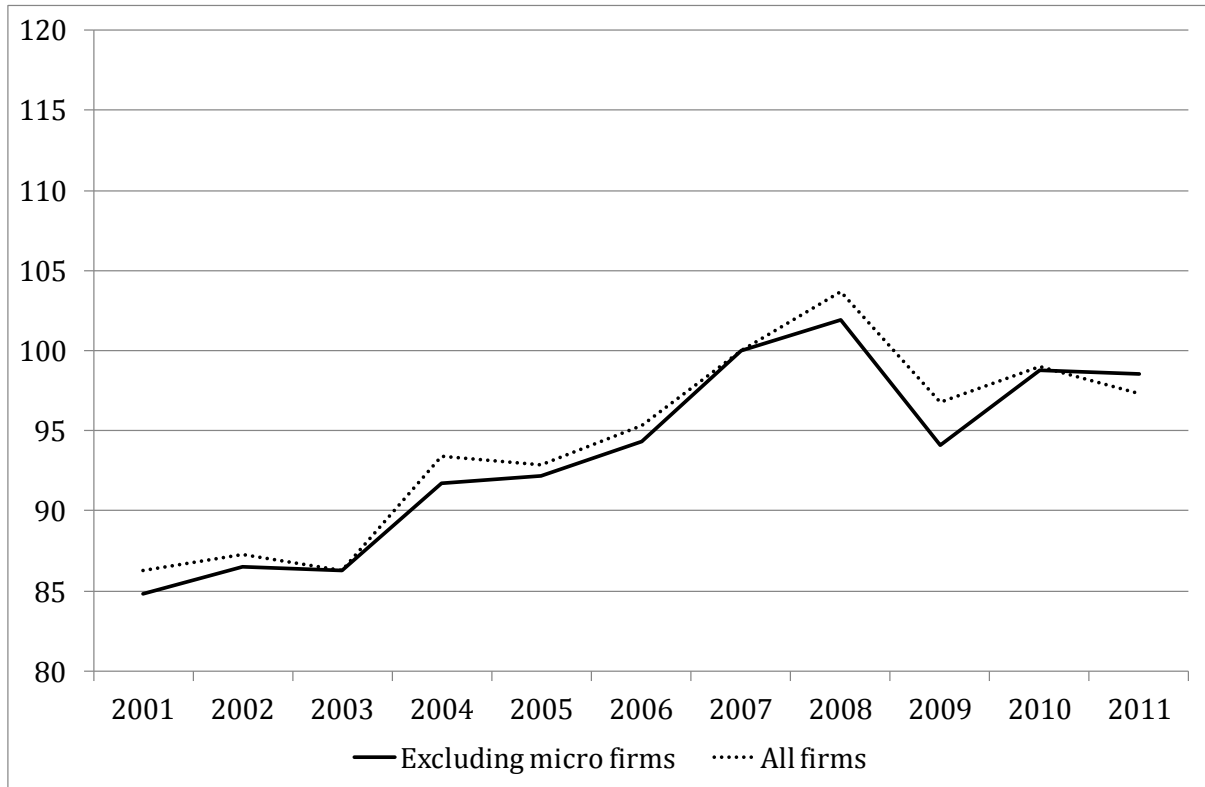


Source: Annual Respondents Database, ONS, and authors' calculations.
Notes: Labor Productivity Indices, 2007=100. Calculations based on annual cross-sections of the ARD, including businesses in non-farm non-financial market sectors excluding real estate, mining & quarrying, and utilities sectors. Micro firms are defined as firms with 0-9 persons in employment.

APPENDIX B

When the intention is for the dynamic productivity decomposition to illustrate productivity dynamics underlying developments in the aggregate economy it is important to weight firm observations accordingly. As Disney *et al.* (2003) suggest it is not always obvious that this is taken into account in productivity decompositions. In any case, despite being potentially crucial to the results, how population weights have been introduced into the decomposition analysis is rarely explicitly described. As discussed in section 2 we define the grossing weight for firm $i$ at time $t$, $g_{it}$, as the ratio of population to survey aggregates (e.g. number of firms or employment) within the industry, employment size and survival status group that a firm belongs to. This takes into account key aspects of the longitudinal sampling strategy, allows us to easily replicate known population market shares, and write the grossed versions of equations (1)-(5) as in (B1)-(B5) below. For continuing firms we set $g_{i,t-k} = g_{it} = g_i$ so that productivity and market share changes for these firms do not reflect changes in grossing weights. We then have aggregate productivity at time $t$ ($\Pi_t$) as a share-weighted average of the productivity of individual firms ($\pi_{it}$):

(B1) $\qquad \Pi_t = \sum_i g_{it} s_{it} \pi_{it}$

where $s_{it} = \frac{e_{it}}{\sum_i g_{it} e_{it}}$ is a measure of firm $i$'s market share at time $t$ (in our case $e_{it}$ is a measure of persons employed in firm $i$ at time $t$), $s_{it} \geq 0$ and $\sum_i g_{it} s_{it} = 1$. The share-weighted average productivity of continuing firms $\Pi_{Ct} = \sum_{i \in C} g_i s_{Cit} \pi_{it}$ (where $s_{Cit} = \frac{s_{it}}{\sum_{i \in C} g_i s_{it}}$). The combined GR/MP decomposition is then:

(B2) $\qquad \Delta\Pi_t = \sum_{i \in C} g_i \overline{s}_{Ci} \Delta\pi_{it}$

$\qquad\qquad + \sum_{i \in C} g_i \Delta s_{Cit} (\overline{\pi}_i - \overline{\Pi}_C)$

$\qquad\qquad + \sum_{i \in N} g_{it} s_{it} (\pi_{it} - \Pi_{Ct})$

$\qquad\qquad - \sum_{i \in X} g_{i,t-k} s_{i,t-k} (\pi_{i,t-k} - \Pi_{C,t-k})$,

and the MP decomposition is:

(B3) $\qquad \Delta\Pi_t = \frac{1}{1 - \overline{cov}_C} \sum_{i \in C} \frac{g_i}{\sum_{i \in C} g_i} \Delta\pi_{it}$

$\qquad\qquad + \frac{\overline{\Pi}_C}{1 - \overline{cov}_C} \Delta cov_{Ct}$

$\qquad\qquad + \sum_{i \in N} g_{it} s_{it} (\pi_{it} - \Pi_{Ct})$

$\qquad\qquad - \sum_{i \in X} g_{i,t-k} s_{i,t-k} (\pi_{i,t-k} - \Pi_{C,t-k})$

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

The GR decomposition:

(B4)
$$\Delta\Pi_t = \sum_{i \in C} g_i \bar{s}_i \Delta\pi_{it}$$

$$+ \sum_{i \in C} g_i \Delta s_{it} (\bar{\pi}_i - \bar{\bar{\Pi}})$$

$$+ \sum_{i \in N} g_{it} s_{it} (\pi_{it} - \bar{\bar{\Pi}})$$

$$- \sum_{i \in X} g_{i,t-k} s_{i,t-k} (\pi_{i,t-k} - \bar{\bar{\Pi}}).$$

The FHK decomposition:

(B5)
$$\Delta\Pi_t = \sum_{i \in C} g_i s_{i,t-k} \Delta\pi_{it}$$

$$+ \sum_{i \in C} g_i \Delta s_{it} (\pi_{i,t-k} - \Pi_{t-k}) + \sum_{i \in C} g_i \Delta s_{it} \Delta\pi_{it}$$

$$+ \sum_{i \in N} g_{it} s_{it} (\pi_{it} - \Pi_{t-k})$$

$$- \sum_{i \in X} g_{i,t-k} s_{i,t-k} (\pi_{i,t-k} - \Pi_{t-k}).$$