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Abstract

The global financial crisis and its aftermath heightened awareness of the role of credit frictions in affecting aggregate economic performance. An important question is whether capital is being allocated to its most productive uses. This paper examines the process through which credit is reallocated across surviving UK businesses over 2004-2012 using the methodology developed by Davis and Haltiwanger (1992) for the analysis of job reallocation. We find that credit reallocation among survivors is intense, and that it primarily occurs across firms similar in size, industry, or location. The results suggest that the aftermath of the global financial crisis has been characterized by persistently increased levels of credit reallocation. However, the evolution of the intensity of credit reallocation after the crisis varies greatly by firm size as measured by sales, with firms in the middle of the distribution driving the overall elevated levels of reallocation in the post-crisis period. When focusing on the sub-sample of larger firms we use to examine the efficiency of the reallocation process, reallocation flows appear to have decreased to levels lower than pre-crisis after a sharp increase in 2007-2008. In terms of efficiency developments, we find that the productivity slowdown of 2008-2009 does not coincide with a deterioration of allocative efficiency along three crucial dimensions of firm performance, namely TFP, labour productivity, and default risk. However, the credit crunch of 2008-2009 coincides with a slowdown of year-on-year efficiency improvements, which persists until the end of the sample period. This raises the prospect that the financial crisis might have undermined the ability of lenders to channel credit to its most productive uses.

Keywords: credit reallocation, productivity, credit shock, Great Recession

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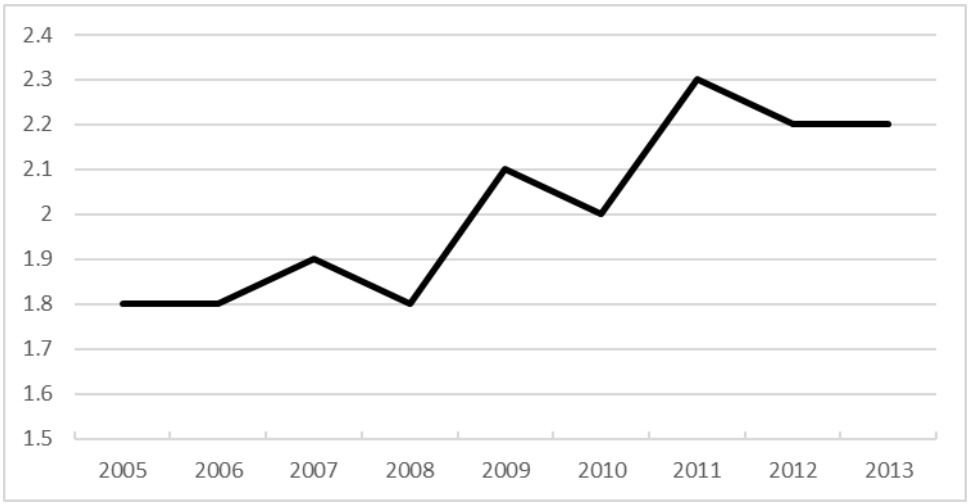
1 Introduction

Labour productivity growth slowed sharply following the global financial crisis of 2007-2008 in many advanced economies. The UK was particularly badly hit and GDP per hour worked only recovered to its pre-crisis levels in 2017. The productivity decline was accompanied by a fall in business investment that was significantly larger than in previous recessions (Benito et al., 2010). There are many factors that could explain the decline in investment such as weak demand, pessimism over future TFP growth and uncertainty. But the financial crisis also led to restrictions in bank lending to non-financial corporations. Bank lending to the corporate sector in the UK continued to contract long after the acute phase of the credit crisis. Work on the role of credit supply and its allocation across firms in the UK remains sparse. Evidence on the productivity decline points to a role played by the adverse credit supply shock. Franklin et al. (2015) use financial statement data for a set of UK firms and information on the identity of firms' lenders in the pre-crisis period to identify the negative impact of the contraction in credit supply on labour productivity, wages and the capital intensity of production at the firm level. Besley et al. (2019) study the implications of credit frictions for *aggregate* output and productivity through the lens of default risk. From a lender's perspective, the main reason for declining an application for a loan or overdraft is that they judge that the potential borrower is unlikely to be able to service the debt. Risk perceptions by banks have increased significantly since the financial crisis. The authors examine how this translates into output and productivity losses. They estimate that credit frictions caused output losses of around 27.5% per year on average over the period 2005-2013. Output losses due to credit frictions are much larger for SMEs (firms with under 250 employees). They stand at 32.6% per year on average, compared to 20% for large firms. This is consistent with SMEs being on average perceived as riskier and accordingly facing tighter credit constraints. The overall losses increased substantially following the global financial crisis, accounting for over half of the productivity fall between 2008 and 2009, and persisted thereafter for smaller (although not larger) firms. The authors also find that output losses are overwhelmingly due to a lower overall capital stock rather than a misallocation of credit across firms (TFP losses). Nevertheless, misallocation caused an annual 2% loss of output on average over the period 2005-2013 - pointing to the fact that the allocation of credit across firms plays a role in aggregate economic performance in addition to the overall volume of credit employed by the business sector.[1] Despite the fact that losses from misallocation are

[1]The idea that the allocation of resources, and not just their overall volume, plays a role for aggregate economic performance is explored in e.g. Foster, Haltiwanger and Krizan (2002),

relatively small, their time series pattern indicates that misallocation has worsened since the financial crisis (See Figure 1).

Figure 1: TFP losses due to misallocation of credit (%)



Source: Besley, Roland, and Van Reenen (2019).

In light of the importance of the allocation of resources across firms for aggregate economic performance, we study the dynamic process of credit reallocation among surviving businesses in the UK over the period 2004-2012. We follow Herrera et al. (2011) in adopting the statistical methodology developed by Davis and Haltiwanger (1992) and Davis et al. (1996) for the measurement of job reallocation. Our aim is to provide a descriptive picture of credit creation, destruction, and reallocation in the UK, which can inform researchers and provide guidance for models that investigate the interaction between financial factors and aggregate economic performance. We compute inter-firm flows of credit and compare their empirical properties with those of the inter-firm flows of sales. We examine the cross-sectional properties of credit reallocation and how it varies across sectors, firm size classes, and geographies. We then turn to the time series properties of credit reallocation, with a focus on the Great Recession and its aftermath. We examine whether the financial crisis stimulated or depressed the reallocation of credit, and explore whether reallocation has been efficiency enhancing. Following Hyun and Minetti (2019), we construct an index for the efficiency of the allocation of credit adapting the index for the efficiency of investment allocation in Galindo, Schiantarelli, and Weiss (2007). We examine "efficiency" along four dimensions, namely the profitability, TFP, labour productivity, and default risk of the firms receiving credit.

Restuccia and Rogerson (2008), Hsieh and Klenow (2009, 2014), Bartelsman, Haltiwanger and Scarpetta (2013), Asker et al. (2014), Gopinath et al. (2017).

We focus on debt (credit from firms' perspective), which represents the main form of external finance for UK businesses. The UK is a nation of small and medium-sized enterprises (SMEs). SMEs accounted for 99.9% of all private sector businesses at the start of 2017, and 60% of all private sector employment. Unlike larger firms which can have recourse to other sources of finance, for instance by issuing bonds or equities, SMEs are more likely to be constrained by the availability of credit. In 2010, only around 2% of SMEs used external equity as a source of finance (BIS, 2010). Armstrong et al. (2013) show that SMEs have faced a very challenging environment for accessing credit after the financial crisis and during the subsequent recession. We rely on Bureau Van Dijk's Orbis database to collect firm-level data on debt (both short-term and long-term) and sales. We also use Orbis to collect data that enables us to estimate firm-level total factor productivity (TFP) and labour productivity for a sub-sample of firms.

The paper documents that in every year of the sample period 2004-2012, inter-firm credit flows exceed those needed to accommodate net credit changes. We find that the reallocation of short-term debt is on average more intense than the reallocation of long-term debt. Credit reallocation is a continuous, quantitatively important process. However, we find that the reallocation of credit among surviving firms is less intense than that of sales. We find that large changes are an important proportion of all credit changes, suggesting that firms face non-convex adjustment costs. The data also reveal that on average the intensity of credit reallocation among surviving businesses in the UK varies somewhat across industries, size classes, public versus private status, and geographies. However, the reallocation of credit within groups of firms similar in size, industry, private versus public status, or location is more intense than the reallocation across groups. Focusing on the time series patterns, we find a sharp increase in credit reallocation from 2007-2008 onwards. Credit creation slumped in 2008-2009 and 2009-2010, whereas credit destruction increased - resulting in negative credit changes in 2008-2009 and 2009-2010. Credit creation recovered from 2010-2011 onwards to reach levels similar to the peak observed in 2007-2008 by the end of 2012. Despite the fact that credit destruction remained at levels higher than pre-crisis through to the end of the sample period, the credit recovery (positive net credit changes) is visible from 2010-2011 onwards. In the overall sample, credit reallocation remained noticeably more intense in the aftermath of the financial crisis, up to the end of our sample period. However, the evolution of the intensity of the reallocation process post-crisis varies greatly by size categories,

with larger firms (defined as being in the fourth quartile of the sales distribution) experiencing a decrease in the intensity of the reallocation process after the initial increase of 2007-2008. When focusing on the sub-sample of larger firms we use to examine the efficiency of the reallocation process, reallocation flows appear to have decreased to levels lower than pre-crisis after an increase in 2007-2008. When looking at efficiency, we find that reallocation was efficiency enhancing before the financial crisis. The credit shock of 2008-2009 does not coincide with a deterioration of allocative efficiency along three dimensions of firm performance, namely TFP, labour productivity, and default risk. However, it coincides with a slowdown of year-on-year efficiency improvements, which persists until the end of the sample period. This raises the prospect that the financial crisis might have undermined the ability of lenders to channel credit to its most productive uses.

The rest of the paper proceeds as follows. Section 2 describes our data sources and methodology. Section 3 investigates the magnitude and cross-sectional properties of credit reallocation. Section 4 characterizes the time series properties of reallocation, with a focus on the Great Recession and the efficiency of the reallocation process. Section 5 concludes.

2 Data and Methodology

2.1 Data

Our main source of data is Bureau Van Dijk's Orbis database, which provides information on the balance sheets and income statements of UK businesses. Being interested in firms that demand rather than supply credit, we remove financial firms from our sample.[2] As opposed to Herrera et al. (2011) who focus on publicly traded firms in the US, our dataset encompasses both private and public firms. This is important as the UK, like the US, is a nation of small businesses, which are typically also private businesses. SMEs accounted for 99.9% of all private sector businesses at the start of 2017, and 60% of all private sector employment. On the downside, we only have access to a short time period with satisfactory data coverage, namely 2004-2012, which prevents us from exploring the cyclical properties of credit reallocation. We collect data on total debt (credit from a firm's perspective), as well as a breakdown of total debt into short-term and long-term debt. It is important to make a distinction between short-term and long-term credit. Short-term debt

[2]We identify financial firms as those with two-digit code 40 according to the Global Industry Classification Standard (GICS).

mostly provides working capital that enables firms to bridge the time lag between the financing of current business operations (e.g. payment of wages) and the accrual of returns. By contrast, long-term debt typically finances long-term plans (e.g. capital investment). To the extent that long-term investment is one of the main determinants of firms' output and productivity, the allocation of long-term debt plays a more important role for aggregate economic performance. We collect data on sales in order to examine how quantitatively important the process of credit reallocation is, compared to the reallocation of sales.[3] We deflate the data using an implied GDP deflator calculated for each two digit UK Standard Industrial Classification code using ONS data.

A caveat of the analysis is that our data requirements do not allow us to work with the entire population of firms in Orbis. We start with 5.6m observations on the growth of total debt, but are left with only 0.9m when we condition on observing the growth of total debt, short-term debt, long-term debt, and sales.[4] The data requirements mean that our sample will be biased towards larger firms as these have better data coverage in Orbis. In addition, when we focus on the time series patterns and the Great Recession, we exploit data on firms' productivity (both TFP and labour productivity) and default risk. This imposes further data requirements that shrink the size of the sample. To generate estimates of labour productivity and TFP, we follow Gal (2013). Specifically, we use the "value added method" of Gal (2013) to estimate labour productivity and the "Wooldridge method" (Woolridge, 2009) to estimate TFP[5]. Due to the data requirements of the estimation procedure, we are only able to estimate productivity for a small sub-sample of firms (250K observations).[6] Because larger firms have better data coverage in Orbis, this will introduce a further bias towards larger firms. Data on default risk is taken from Besley et al. (2019) who use S&P's PD Model and CreditPro to estimate a time-varying probability of default at the firm-level with Orbis data. The estimates of default risk represent the probability that a firm will default on its debt obligations within one year.

In addition to limited data availability for the data items of interest, we face severe measurement issues regarding firm entry and exit. Specifically, we do not have

[3]There is not enough data on employment in Orbis to enable us to compare the reallocation of credit to the reallocation of jobs.

[4]Appendix Table 1 gives the number of observations per year in our samples.

[5]We use the prodest command in Stata (Mollisi, 2017).

[6]Appendix Table 1 gives the number of observations per year in our samples.

access to the historical version of the Orbis database and lack information on why firms enter or exit our dataset. Firms that enter our dataset could either be genuine entrants (new firms) or existing firms on which the data we require was previously unrecorded in Orbis. A comparison between the annual numbers of firms that enter our dataset each year and ONS statistics on newly created firms clearly indicates that the main reason for new entries in our dataset is most likely linked to data recording issues rather than genuine entry. Therefore, treating the debt of existing firms as new debt would lead to severe overestimation of credit creation. To avoid counting the debt of existing firms that enter the dataset as credit creation, we ignore firms that newly enter the dataset in each year. This means that we ignore credit creation resulting from entry. For consistency and because Orbis does not provide any information on why a firm exits the dataset, we also abstract from credit destruction due to firm exit. In other words, we focus on surviving firms. This will lead to an underestimation of credit flows, but enables us to know exactly what we are measuring.

2.2 Methodology

2.2.1 Measurement of credit flows

To measure credit flows, we adopt the methodology of Herrera et al. (2011), who follow the methodology developed by Davis and Haltiwanger (1992) and Davis et al. (1996) for the measurement of job flows. Denote with $c_{f,t}$ the average debt of a firm f across periods $t-1$ and t. For a group s of firms this average is similarly denoted $C_{s,t}$. The growth rate of debt for firm f is denoted $g_{f,t}$. It is defined as the first difference of debt divided by $c_{f,t}$. This takes a minimum value of -2 for firms that pay off all of their debt and a maximum value of 2 for firms going from no debt to some debt.[7]

As in Herrera et al. (2011), we consider five measures of aggregate credit flows. Given a set s of firms, credit creation at time t ($POS_{s,t}$) is calculated as the weighted sum of the debt growth rates of firms which became more indebted (firms with rising debt since our sample is restricted to survivors). Each firm's growth rate is weighted by $\frac{c_{f,t}}{C_{s,t}}$.

$$POS_{s,t} = \sum_{\substack{f \in s \\ g_{f,t}>0}} g_{f,t} \frac{c_{f,t}}{C_{s,t}} \tag{1}$$

[7] As explained in Herrera et al. (2011), $g_{f,t}$ is a monotonic transformation of the percentage change and roughly coincides with it for small growth rates. It involves two crucial benefits relative to the percentage change. Specifically, it is bounded and symmetric around zero.

Analogously, credit destruction ($NEG_{s,t}$) is calculated as the weighted sum of the absolute values of the debt growth rates of firms which became less indebted (firms with shrinking debt since our sample is restricted to survivors).

$$NEG_{s,t} = \sum_{\substack{f \in s \\ g_{f,t} < 0}} |g_{f,t}| \frac{c_{f,t}}{C_{s,t}} \tag{2}$$

Credit reallocation ($SUM_{s,t}$) is defined as the sum of credit creation and credit destruction.

$$SUM_{s,t} = POS_{s,t} + NEG_{s,t} \tag{3}$$

Net credit change ($NET_{s,t}$) is defined as credit creation minus credit destruction.

$$NET_{s,t} = POS_{s,t} - NEG_{s,t} \tag{4}$$

Excess credit reallocation ($EXC_{s,t}$) is defined as the reallocation in excess of the absolute value of net credit change ($NET_{s,t}$). It measures credit reallocation in excess of the minimum required to accommodate net credit changes.

$$EXC_{s,t} = SUM_{s,t} - |NET_{s,t}| \tag{5}$$

2.2.2 Efficiency

To examine whether reallocation is efficiency enhancing, we follow Hyun and Minetti (2019) and adapt the index for the efficiency of investment allocation in Galindo, Schiantarelli, and Weiss (2007). The index is a ratio. In the numerator, in year t, it includes the weighted sum of profitabilities (sales to capital ratios) of the firms, with the weight for each firm given by the contribution of the firm's debt to the total debt of the firms in that year $\left(\frac{c_{f,t}}{C_t}\right)$. In the denominator, it includes the sum of the profitabilities (sales to capital ratios) of the same firms weighted by the contribution of the firm's debt to the total debt in the previous year $\left(\frac{c_{f,t-1}}{C_{t-1}}\right)$. For example, using the sales to capital ratio $\left(\frac{s_{f,t}}{k_{f,t}}\right)$ as in Hyun and Minetti (2019), the index is given by:

$$I_t = \frac{\sum_f \frac{s_{f,t}}{k_{f,t}} \frac{c_{f,t}}{C_t}}{\sum_f \frac{s_{f,t}}{k_{f,t}} \frac{c_{f,t-1}}{C_{t-1}}} \tag{6}$$

Capital reallocation from unprofitable to profitable firms is a key source of productivity growth. A value of the index greater than one signals that credit was allocated more efficiently in year t than if the credit distribution had remained the same as in year $t-1$. In addition to looking at profitability, we exploit data on default risk

(repayment probabilities), TFP, and labour productivity. This index will help us explore the question of whether the financial crisis enhanced the ability of lenders to reallocate credit towards firms with higher profitability, higher productivity, and lower default risk.

3 Magnitude and Cross-Sectional Properties

3.1 Magnitude and Persistence

Table 1 presents our estimates of average credit creation, credit destruction, net credit change, credit reallocation and excess credit reallocation for the period 2004-2012.[8] The average rate of total credit creation over the sample period is 18.7%, while average credit destruction is 13.6%. Hence the average net change in credit was 5.1% and the average credit reallocation was 32.3%. We find that aggregate credit flows are much larger than the net flows of credit as shown by excess credit reallocation averaging 26.1%. Table 1 also breaks down total credit into short-term and long-term debt. We find that average short-term debt flows are larger than flows of long-term debt. This is true for creation, destruction, net change, reallocation and excess reallocation. For example, average credit reallocation over the period was 46.2% for short-term debt compared to 34.3% for long-term debt.

Table 1: Average Credit Flows and Comparison With Flows of Sales

Average Flows	Observations	POS	NEG	NET	SUM	EXC	P
Total Credit (04-12)	898,658	0.187	0.136	0.051	0.323	0.261	0.522
Long Term Credit (04-12)	898,658	0.195	0.147	0.048	0.343	0.271	0.502
Short Term Credit (04-12)	898,658	0.260	0.202	0.057	0.462	0.387	0.499
Sales (04-12)	898,658	0.314	0.272	0.042	0.586	0.282	0.440

Notes: The sample conditions on the availability of data on the growth of total debt, long-term debt, short-term debt and sales.

Table 1 also contains our estimates of flows for sales, computed using the same methodology. A comparison with credit flows can help us ascertain how economically important credit flows are. For sales, the average rate of creation (destruction) equals 31.4% (27.2%), the average reallocation 58.6%, the average net change is 4.2%, while the average excess reallocation is 28.2%. The net flows of credit are

[8] Table 2 in the Appendix shows that the results are fairly robust when we work with the subsample of firms for which we can obtain estimates of default risk, TFP and labour productivity.

slightly larger than those of sales. However, the reallocation of credit is on average less intense than that of sales among surviving UK businesses.

We are also interested in whether changes in credit are due to temporary or persistent changes in debt. To ascertain which is the case, we use the same measure of persistence as Herrera et al. (2011):

$$P_{f,t} = min\left[1, max\left(\frac{growth\,rate\,t\,to\,t+2}{growth\,rate\,t\,to\,t+1}, 0\right)\right] \tag{7}$$

Persistence is highest when $\mathrm{P}_{f,t} = 1$, that is changes from t to $t+1$ last an additional year. And it is lowest when $\mathrm{P}_{f,t} = 0$, which is when debt changes do not carry over at all to the next year. The results are in the last column of Table 1. The persistence of flows of total credit is 0.522, suggesting that a sizable proportion of the yearly flows are due to temporary firm-level debt changes. We break down the results according to whether debt is short-term or long-term and find that changes in long-term debt are not substantially more persistent than changes in short-term debt.

3.2 Adjustment Costs

An extensive literature argues that firms adjust labour and capital in a lumpy way (see, e.g., Davis et al., 2006). If firms face sizable non-convex adjustment costs, they will prefer to make infrequent and large adjustments rather than frequent and small ones. Because non-convex adjustment costs are well-known in the theory of investment of the firm, it is interesting to see whether such an argument applies to credit, especially long-term credit which finances such investment. Therefore, we explore to what extent large credit changes contribute to credit reallocation. To explore this, we follow Herrera et al. (2011) and define firms with large changes as having $|g_{f,t}| > 0.18$. Table 2 reports our estimates of credit flows attributable to large changes.

Table 2: Average Flows Due to Large Changes

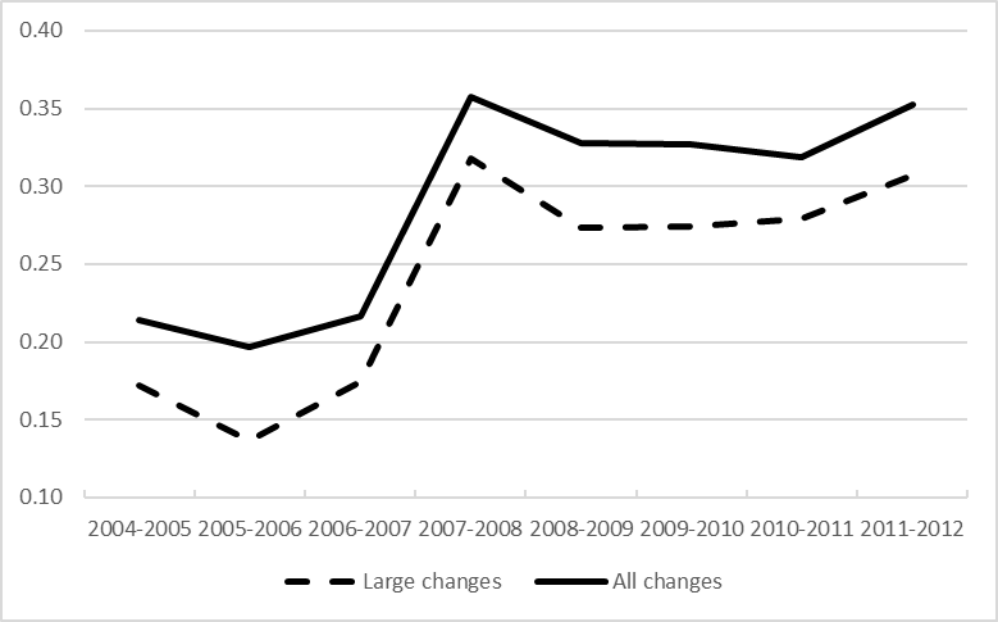
Average Flows	Observations	POS	NEG	NET	SUM	EXC
Total Credit (04-13)	477,756	0.158	0.122	0.037	0.280	0.232
Long Term Credit (04-13)	527,861	0.168	0.133	0.035	0.300	0.246
Short Term Credit (04-13)	653,481	0.238	0.190	0.048	0.428	0.359
Sales (04-13)	737,984	0.295	0.263	0.032	0.558	0.255

Notes: The sample conditions on the availability of data on the growth of total debt, long-term debt, short-term debt and sales.

We find that large changes are an important proportion of all credit changes. Specifically, 86.7% of total average reallocation is due to large changes. This is lower than the percentage of sales reallocation due to large changes (95.3%). This suggests the presence of non-convex adjustment costs.

Figure 2 plots reallocation due to large changes against total reallocation over time. They appear to track each other closely. This is in line with the results of Herrera et al. (2011), who highlight that this echoes the finding of Gourio and Kashyap (2007) that large investment changes dominate the variation in aggregate investment.

Figure 2: Average Flows Due to Large Changes



3.3 Cross-Sectional Properties and Within-Between Group Reallocation

In this section, we examine whether credit reallocation varies according to a number of dimensions of interest, including sectors, size (proxied by sales), private versus public status, and geographies. We also examine whether the reallocation of credit occurs within groups of similar firms or between groups of firms. The reallocation of credit may stem from the reshuffling of credit within groups of firms with similar characteristics (same sector, same size class, same geography, etc.) or from the reallocation of credit across groups. Because the factors driving within-group and across-groups reallocation might be very different, it is useful to disentangle the contribution of the within-group and the cross-group reallocation. Following Herrera et al. (2011), we use the index of Davis and Haltiwanger (1992) to measure to what extent reallocation occurs within groups or between groups:

$$W_t = 1 - \frac{\sum_{s=1}^{S} |NET_{s,t}|}{\sum_{s=1}^{S} SUM_{s,t}} \tag{8}$$

where $s = 1...S$ denotes the groups. If in group s there is only credit creation or destruction, $SUM_{s,t} = |NET_{s,t}|$. If this occurs for every group, then $W_t = 0$. Therefore, $W_t = 0$ means that all reallocation occurs between groups of firms whereas $W_t = 1$ means that all reallocation occurs within groups of firms. Table 3 presents average flows calculated for different groups of firms, alongside the corresponding values of this index.

Table 3: Cross-Sectional Properties (2004-2012)

	Observations	POS	NEG	NET	SUM	EXC	W
Panel A: Sectors							
Manufacturing	113,103	0.184	0.150	0.034	0.334	0.274	0.790
Services	387,590	0.190	0.152	0.038	0.341	0.266	
Rest of the economy	397,965	0.184	0.119	0.066	0.303	0.230	
Panel B: Sales quartiles							
0 - 25%	224,665	0.188	0.120	0.067	0.308	0.241	0.820
25% - 50%	224,664	0.167	0.147	0.021	0.314	0.277	
50% - 75%	224,665	0.178	0.169	0.009	0.348	0.296	
75% - 100%	224,664	0.195	0.141	0.054	0.336	0.259	
Panel C: Private versus public firms							
Private firms	895,644	0.187	0.141	0.047	0.328	0.272	0.672
Public Firms	3,014	0.179	0.092	0.086	0.271	0.126	
Panel D: Regions							
England	239,471	0.188	0.124	0.064	0.313	0.244	0.725
Scotland	17,609	0.182	0.164	0.018	0.347	0.281	
Wales	7,499	0.170	0.101	0.069	0.272	0.180	
Northern Ireland	5,400	0.205	0.109	0.097	0.314	0.189	

Notes: Panels A, B, and C condition on the availability of data on the growth of total debt, long-term debt, short-term debt and sales. Panel D works with a more limited sample of firms for which location data is available.

Panel A of Table 3 partitions the dataset into three broad sectoral categories, namely manufacturing, services, and the rest of the economy. The results show that significant flows of credit creation and destruction coexist within all sectors, but that the intensity of credit reallocation does not vary much across sectors. In addition, we find that on average most of the reallocation occurs within sectors (average W=0.790). However, when we consider industries at a more disaggregated level (3 digits), the average W index goes down to 0.676. Nevertheless, this still implies that the majority of credit reallocation occurs within industries. In other words, it is generated by intra-sectoral heterogeneity in firms' debt dynamics as opposed to sectoral shocks or the different impact of aggregate shocks on sectors.

Panel B breaks down the dataset into four size categories based on sales (4 quartiles). The results indicate that on average the intensity of credit reallocation does not vary

hugely across size categories as proxied by sales, although it is slightly higher for larger firms (quartiles 3 and 4). In addition, we find that most reallocation occurs within size quartiles (average W=0.820). This suggests that the reallocation activity in the credit market goes beyond the flights to quality from small to large firms typically observed during recession episodes.

In Panel C, we examine whether credit flows differ depending on whether firms are publicly listed or private. Public firms have a much higher net credit change than private firms on average (8.6% against 4.7%, respectively). This is driven by lower credit destruction for public firms. In addition, private firms have a higher average for credit reallocation than public firms, 32.8% against 27.1%. However, we find that on average most of the reallocation occurs within groups of firms (average W=0.672), although to a lesser extent than when we break down the data by broad sector or size. This might capture an element of flight to quality from private to publicly listed firms.

Finally, in Panel D we explore the geographical distribution of credit reallocation. The estimates show that all regions of the UK experience intense credit reallocation on average. However, the intensity varies geographically, with Scotland exhibiting the highest average credit reallocation of the four countries and Wales the lowest. Finally, we find that the majority of credit is reallocated within the countries that make up the United Kingdom (average W=0.725).

4 Time Series Properties and the Great Recession

We now look at how credit reallocation and net credit changes change over time, with particular interest in looking at how the Great Recession may have altered credit flows. Table 4 presents the yearly average credit flows and Figure 3 presents a graphic depiction of the results. Here we make use of the full sample, i.e. just condition on data availability on the growth of total debt, in order to come closer to the aggregate picture.

The yearly data reveal the simultaneous presence of large positive and negative credit flows at any phase of the business cycle. The credit crunch is visible in 2008-2009 and 2009-2010. Credit creation slumped in 2008-2009 and 2009-2010, while credit destruction increased simultaneously. These patterns resulted in negative net credit changes in 2008-2009 and 2009-2010. Credit creation recovered from 2010-

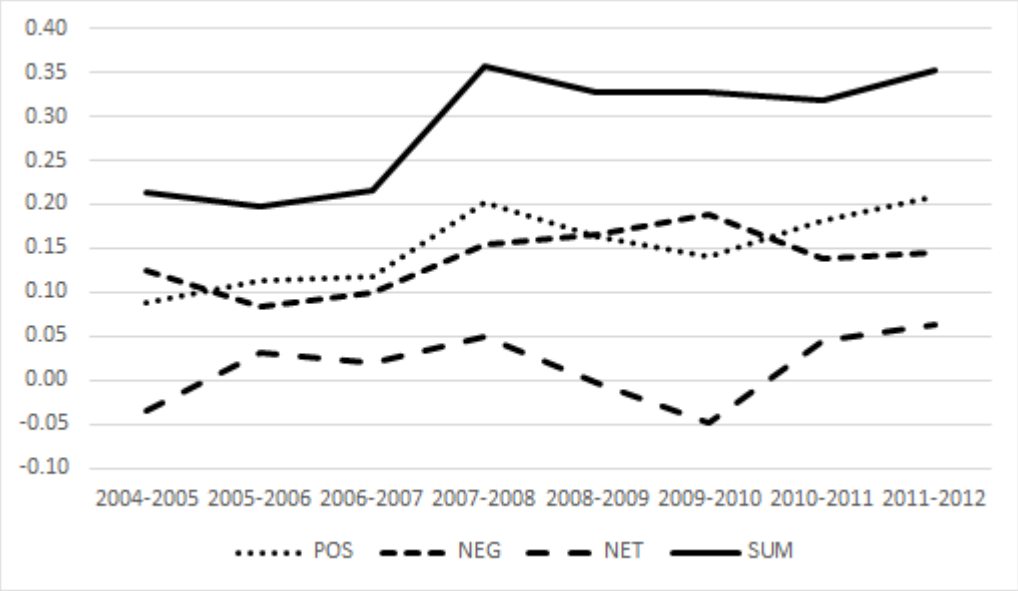
2011 onwards to reach levels similar to the peak observed in 2007-2008 by the end of 2012. Despite the fact that credit destruction remained at levels higher than pre-crisis through to the end of the sample period, the credit recovery is visible from 2010-2011 onwards in the shape of positive net credit changes. Credit reallocation increased noticeably in 2007-2008 and remained elevated in the post-crisis years. This suggests that the reallocation process was not hindered by the Great Recession, on the contrary.

Table 4: Average credit flows over time

	Observations	POS	NEG	NET	SUM	EXC
2004-2005	657,088	0.089	0.125	-0.036	0.214	0.178
2005-2006	720,081	0.114	0.083	0.031	0.197	0.165
2006-2007	656,092	0.118	0.099	0.019	0.217	0.197
2007-2008	628,970	0.203	0.154	0.049	0.357	0.309
2008-2009	680,095	0.162	0.165	-0.003	0.328	0.325
2009-2010	701,743	0.140	0.187	-0.047	0.327	0.280
2010-2011	739,952	0.181	0.137	0.044	0.318	0.275
2011-2012	784,394	0.208	0.145	0.063	0.352	0.289

Notes: The sample conditions on the availability of data on the growth of total debt.

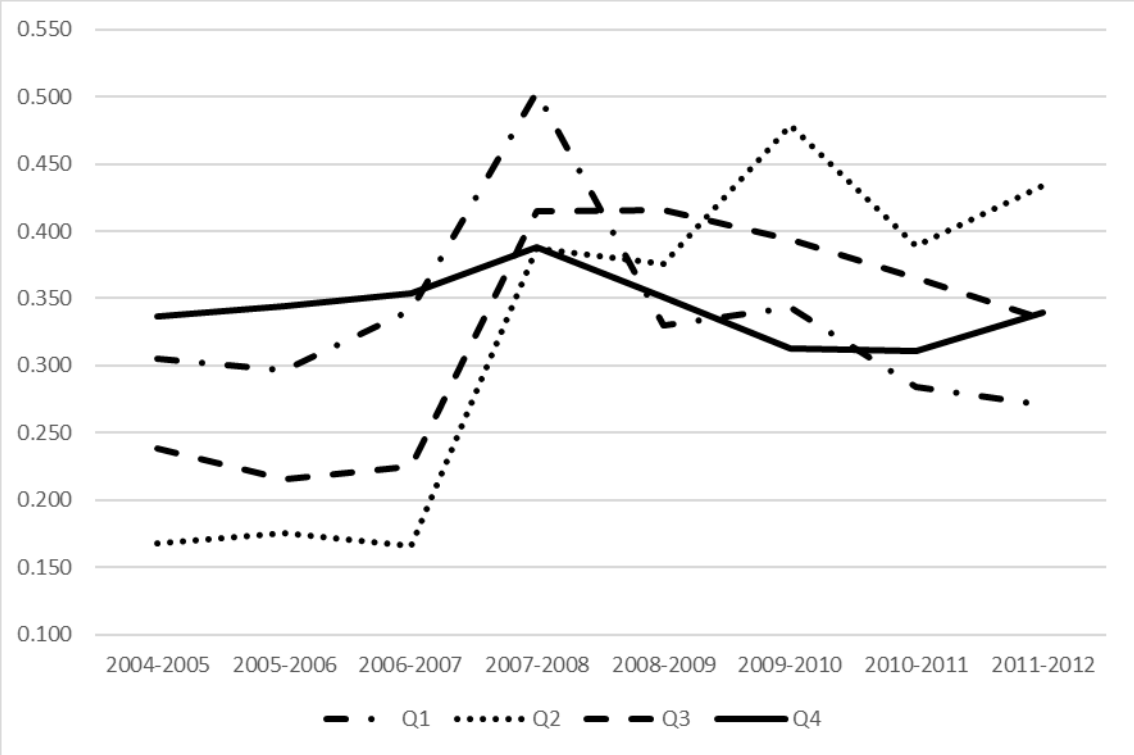
Figure 3: Average credit flows over time



Notes: The sample conditions on the availability of data on the growth of total debt.

The evolution of the intensity of the reallocation process post-crisis appears to vary greatly by size category. Figure (4) breaks down the sample into four sales quartiles and shows the intensity of the reallocation process over time. All four quartiles experienced an increase in credit reallocation in 2007-2008, although the increase was much milder for the largest firms. After the crisis, the smallest and largest firms (quartiles 1 and 4) witnessed a decrease in reallocation, returning to pre-crisis levels or below. By contrast, reallocation remained elevated for firms in the middle of the distribution (quartiles 2 and 3) until the end of the sample period.

Figure 4: Average credit flows over time by sales quartile



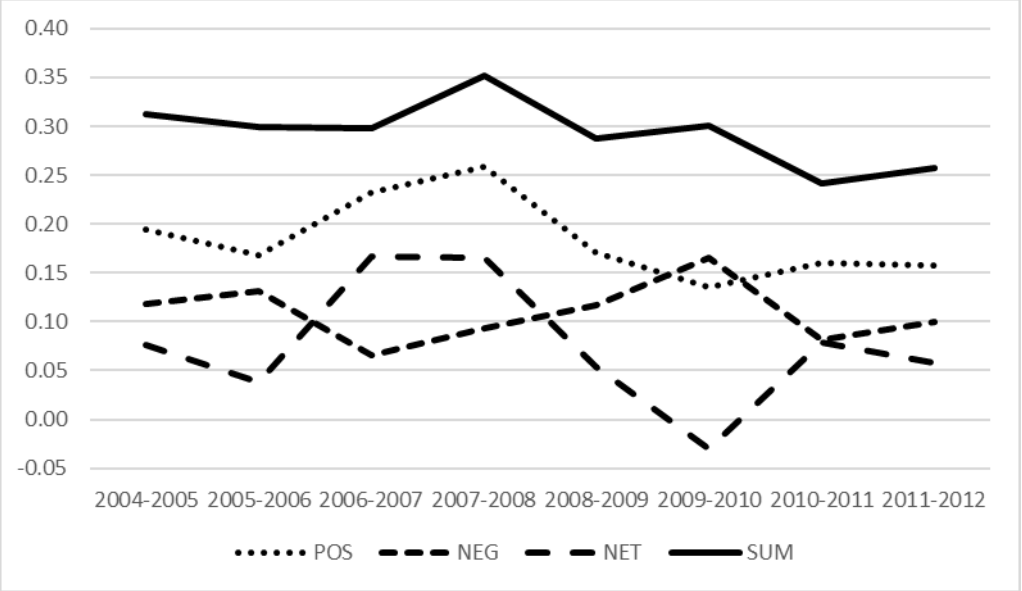
When we condition on observing the growth of total debt and sales, as well as default risk, TFP, and labour productivity - which is the sample we use to examine the efficiency of the reallocation process, reallocation again increases sharply in 2007-2008, but then drops to levels lower than those observed pre-crisis by the end of 2011 (Table 5 and Figure 5). Because of the data requirements, the sub-sample is likely to omit the smallest firms and to be biased towards the largest ones with better data coverage in Orbis.

Table 5: Average credit flows over time

	Observations	POS	NEG	NET	SUM	EXC
2004-2005	33,018	0.194	0.118	0.076	0.312	0.236
2005-2006	31,651	0.169	0.131	0.038	0.300	0.262
2006-2007	29,475	0.232	0.066	0.166	0.298	0.132
2007-2008	28,831	0.259	0.093	0.166	0.352	0.187
2008-2009	28,798	0.171	0.117	0.054	0.288	0.234
2009-2010	31,826	0.135	0.165	-0.030	0.300	0.270
2010-2011	32,875	0.160	0.082	0.078	0.242	0.164
2011-2012	31,949	0.157	0.099	0.058	0.257	0.199

Notes: This table conditions on observing the growth of total debt and sales, as well as default risk, TFP, and labour productivity.

Figure 5: Average credit flows over time

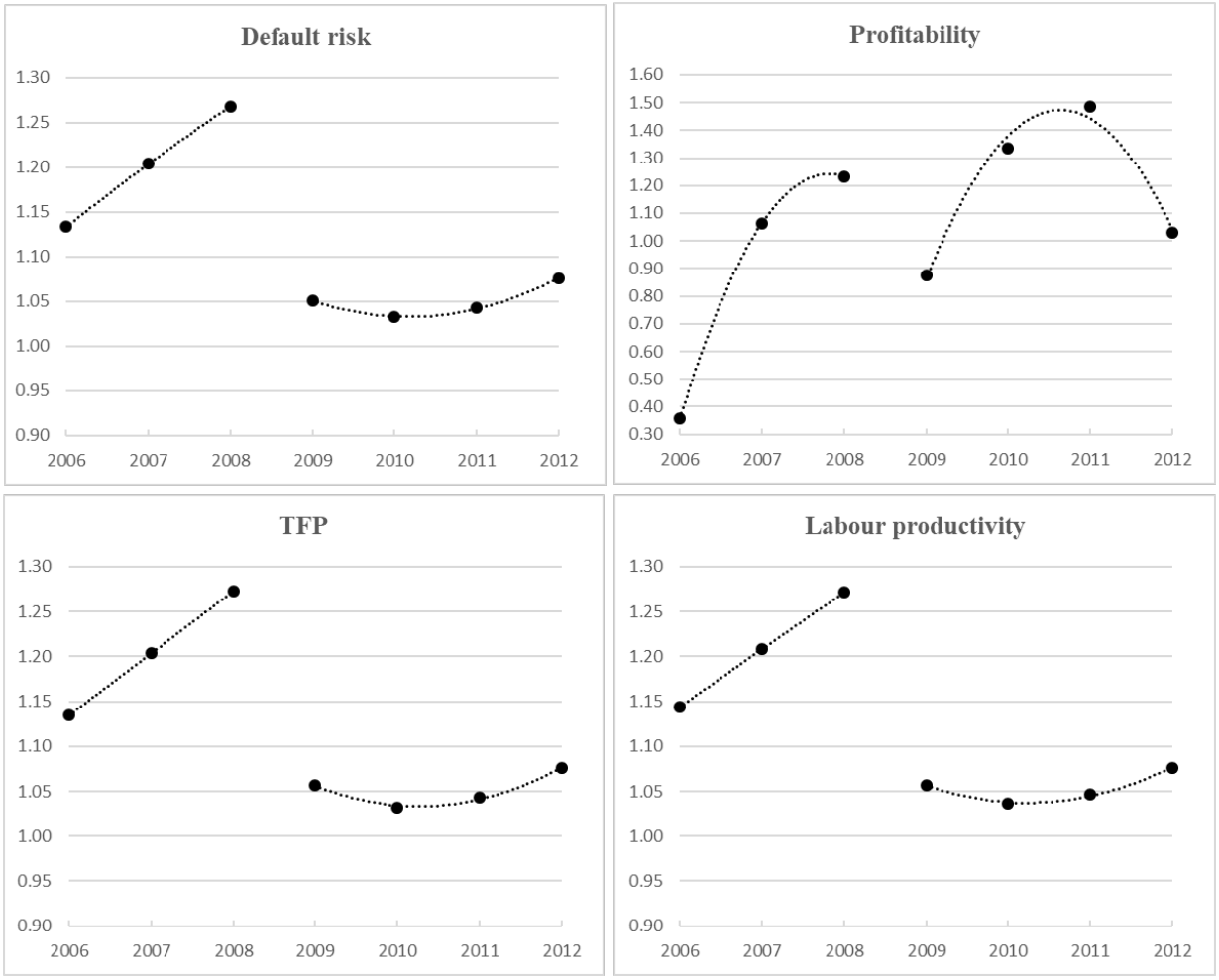


Notes: The sample conditions on observing the growth of total debt and sales, as well as default risk, TFP, and labour productivity.

While they are useful, Tables 4 and 5 and Figures 3 and 5 say nothing about whether the reallocation process is associated with improvements in efficiency, i.e. whether lenders gained better ability to match their funds with efficient and productive firms. To explore this question, we estimate the efficiency index given by Equation (6) using data on profitability (sales to capital ratio), repayment probabilities (equal to 1 minus probabilities of default), TFP, and labour productivity. We are only able to

do this for the sub-sample of Table 5. A value of the index greater than one signals that credit was allocated more efficiently in year t than if the credit distribution had remained the same as in year $t-1$. Figure 6 presents the estimates for the years 2006-2012.[9]

Figure 6: Efficiency indices



The results on default risk, TFP, and labour productivity follow a similar pattern. The figure suggests that before the crisis, the efficiency of reallocation improved from one year to the next. Specifically, the value of the index is larger than 1 ($I_t > 1$) and increasing over time. It jumped down in 2009, but did not fall below 1. This indicates that the credit shock of 2008-2009 does not coincide with a deterioration of allocative efficiency along the three dimensions of firm performance we examine. However, the figure shows that the rate of increase in efficiency post-crisis is lower than in the pre-crisis years. To illustrate this, we fit two separate polynomials of order 2 to

[9]Because of data requirements on debt growth and lagged values, we cannot estimate the index for the years 2004 and 2005.

the data points in 2006-2008 and 2009-2012. Despite the indices remaining above 1 after 2009, the improvements in efficiency from year to year are less marked than in the pre-crisis period. This indicates that the financial crisis might have decreased the ability of lenders to direct credit to its most productive uses. The results on profitability are a bit mixed. There was a deterioration in efficiency in 2009 (with the index falling below 1), followed by a return to year-on-year improvements similar to the pre-crisis period. However, there was a slowdown in 2012. The results on default risk echo concerns about the "rise of zombie firms" (see e.g. Banerjee and Hofmann, 2018), defined as firms that are unable to cover debt servicing costs from current profits over an extended period. Although this is not a dimension of firm performance that we explicitly examine, zombie firms are by definition more likely to default. A less vigorous reallocation of credit from firms with high default risk to firms with low default risk would be a symptom of an increased prevalence of zombies. In turn, zombies are less productive, hence the results on TFP and labour productivity could also be partly driven by this phenomenon. However, uncovering how much of the results are driven by zombies is beyond the scope of this paper.

5 Conclusions

The period following the global financial crisis of 2007-2008 heightened awareness of the role of credit frictions in affecting aggregate economic efficiency, especially productivity. There have been concerns that capital might not be allocated to its most productive uses. To examine this question, we study the process through which credit is reallocated across surviving UK businesses over 2004-2012 using the methodology developed by Davis and Haltiwanger (1992) for the analysis of job reallocation. We find that credit reallocation is a continuous and quantitatively important process. Inter-firm credit flows exceed those needed to accommodate net credit changes. We find that large changes are an important proportion of all credit changes, suggesting that firms face non-convex adjustment costs. The data also reveal that on average the intensity of credit reallocation among surviving businesses in the UK varies somewhat across industries, size classes, public versus private status, and geographies. However, the reallocation of credit within groups of firms similar in size, industry, private versus public status, or location is more intense than the reallocation across groups.

Focusing on the Great Recession, we find a sharp increase in credit reallocation from 2007-2008 onwards. Credit creation slumped in 2008-2009 and 2009-2010, whereas

credit destruction increased - resulting in negative net credit changes in 2008-2009 and 2009-2010. Credit creation recovered from 2010-2011 onwards to reach levels similar to the peak observed in 2007-2008. Despite the fact that credit destruction remained at levels higher than pre-crisis through to the end of the sample period, the credit recovery is visible from 2010-2011 onwards. Credit reallocation remained noticeably more intense in the aftermath of the financial crisis than in the pre-crisis years, up to the end of our sample period. However, the intensity of the reallocation process after the crisis shows variation across firm size classes as measured by sales, with firms in the middle of the distribution driving the elevated levels of reallocation in the post-crisis period. When we condition on observing the growth of total debt and sales, as well as default risk, TFP, and labour productivity - which is the sample we use to examine the efficiency of the reallocation process, reallocation again increases in 2007-2008, but then drops to levels lower than those observed pre-crisis. Because of the data requirements, the sub-sample is biased towards larger firms with better reporting in Orbis. When looking at efficiency, we find that the credit shock of 2008-2009 does not coincide with a deterioration of allocative efficiency along three dimensions of firm performance, namely TFP, labour productivity, and default risk. However, it coincides with a slowdown of year-on-year efficiency improvements, which persists until the end of the sample period. This raises the prospect that the financial crisis might have undermined the ability of lenders to channel credit to its most productive uses.

Two important caveats of our analysis have to be kept in mind. Because of limited data availability, our sample is limited in size. The data requirements mean that our sample will be biased towards larger firms as these have better data coverage in Orbis. In addition, we are unable to take entry and exit properly into account and therefore focus on surviving businesses. This means that our estimates of credit flows are biased downwards. In the future, the analysis should be performed using Orbis Historical.

References

Armstrong, Angus, Phillip Davis, Iana Liadze and Cinzia Rienzo (2013) Evaluating changes in bank lending to SMEs over 2001-2012, National Institute for Economic and Social Research Discussion Paper 408.

Asker, John, Allan Collard-Wexler and Jan De Loecker (2014) Dynamic Inputs and Resource (Mis)Allocation, *Journal of Political Economy*, 122(5), pp.1013-1063.

Banerjee, Ryan, and Boris Hofmann (2018) The Rise of Zombie Firms: Causes and Consequences, BIS Quarterly Review September 2018.

Bartelsman, Eric, Haltiwanger, John and Scarpetta, Stefano (2013) Cross-Country Differences in Productivity: The Role of Allocation and Selection, *American Economic Review*, 103, pp.305-334.

Benito, Andrew, Katherine Neiss, Simon Price, and Lukasz Rachel (2010) The impact of the financial crisis on supply, Bank of England Quarterly Bulletin 2010 Q2, pp.104-114.

Besley, Timothy, Isabelle Roland, and John Van Reenen (2019) The Aggregate Consequences of Default Risk: Evidence from Firm-level Data, Working Paper.

Besley, Timothy and John Van Reenen (2013) Investing for Prosperity, London: LSE Growth Commission.

BIS, Department for Business, Innovation and Skills (2010) Financing a Private Sector Recovery.

Davis, Steven J., Faberman, Jason, Haltiwanger, John (2006) The flow approach to labor markets: new data sources and micro–macro links, *Journal of Economic Perspectives*, 20, pp.3–26.

Davis, Steven J., Haltiwanger, John (1992) Gross job creation, gross job destruction, and employment reallocation, *Quarterly Journal of Economics*, 107, pp.819–863.

Davis, Steven J., Haltiwanger, John, Schuh, Scott (1996) Job Creation and Destruction, MIT Press, Cambridge.

Foster, Lucia, John Haltiwanger, and C.J. Krizan (2002) The Link Between Aggregate and Micro Productivity Growth: Evidence from Retail Trade, NBER Working Paper No. 9120.

Franklin, Jeremy, May Rostom and Gregory Thwaites (2015) The banks that said no: banking relationships, credit supply and productivity in the United Kingdom,

Bank of England Staff Working Paper No.557.

Gal, Peter N. (2013) Measuring Total Factor Productivity at the Firm Level using OECD-ORBIS, OECD Economics Department Working Papers 1049, OECD Publishing.

Galindo, Antonio, Fabio Schiantarelli, and Andrew Weiss (2007) Does Financial Liberalization Improve the Allocation of Investment? Micro-evidence from Developing Countries, *Journal of Development Economics*, 83, pp.562–87.

Gopinath, Gita, Sebnem Kalemli-Ozcan, Loukas Karabarbounis and Carolina Villegas-Sanchez (2017) Capital Allocation and Productivity in South Europe, *Quarterly Journal of Economics*, 132(4), pp.1915-1967.

Gourio, François, Kashyap, Anil K. (2007) Investment spikes: new facts and a general equilibrium exploration, *Journal of Monetary Economics*, 54, Supplement, pp.1–22.

Herrera, Ana Maria, Marek Kolar, and Raoul Minetti (2011) Credit reallocation, *Journal of Monetary Economics*, 58, pp.551–563.

Hsieh, Chang-Tai and Peter J. Klenow (2009) Misallocation and Manufacturing TFP in China and India, *Quarterly Journal of Economics*, 124(4), pp.1403-1448.

Hsieh, Chang-Tai and Peter J. Klenow (2014) The Life Cycle of Plants in India and Mexico, *Quarterly Journal of Economics*, 129(3).

Hyun, Junghwan and Raoul Minetti (2019) Credit Reallocation, Deleveraging, and Financial Crises, *Journal of Money, Credit and Banking*, 51(7), pp.1889-1921.

Mollisi, Vincenzo and Rovigatti, Gabriele (2017) Theory and Practice of TFP Estimation: the Control Function Approach Using Stata, CEIS Research Paper 399, Tor Vergata University, CEIS.

Restuccia, Diego and Richard Rogerson (2008) Policy distortions and aggregate productivity with heterogeneous establishments, *Review of Economic Dynamics*, 11, pp.707-720.

Wooldridge, Jeffrey M. (2009) On estimating firm-level production functions using proxy variables to control for unobservables, *Economics Letters*, 104(3), pp.112-114.

Appendix

Table 1: Number of observations

	Sample 1	Sample 2
2005	145,064	33,018
2006	140,247	31,651
2007	123,861	29,475
2008	113,847	28,831
2009	108,293	28,798
2010	98,060	31,826
2011	88,096	32,875
2012	81,190	31,949
Total	898,658	248,423

Notes: Sample 1 refers to the sample that conditions on observing the growth of total debt, long-term debt, short-term debt, and sales. Sample 2 refers to the sample that conditions on observing the growth of total debt, long-term debt, short-term debt, and sales, as well as default risk, TFP, and labour productivity.

Table 2: Average Credit Flows and Comparison With Flows of Sales

Average Flows	Observations	POS	NEG	NET	SUM	EXC	P
Total Credit (04-12)	248,423	0.185	0.109	0.076	0.294	0.210	0.491
Long Term Credit (04-12)	248,423	0.196	0.109	0.086	0.305	0.211	0.482
Short Term Credit (04-12)	248,423	0.249	0.187	0.062	0.436	0.357	0.441
Sales (04-12)	248,423	0.354	0.150	0.204	0.503	0.238	0.449

Notes: This table conditions on observing the growth of total debt, long-term debt, short-term debt, and sales, as well as default risk, TFP, and labour productivity.