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ABSTRACT

The high pace of reallocation across producers is pervasive in the U.S. economy. Evidence shows this high pace of reallocation is closely linked to productivity. While these patterns hold on average, the extent to which the reallocation dynamics in recessions are "cleansing" is an open question. We find downturns prior to the Great Recession are periods of accelerated reallocation even more productivity enhancing than reallocation in normal times. In the Great Recession, we find the intensity of reallocation fell rather than rose and the reallocation that did occur was less productivity enhancing than in prior recessions.

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1. Introduction

The Great Recession is unusually severe and persistent relative to post-WWII recessions; we explore whether its impact on productivity-enhancing reallocation is also unusual. A pervasive feature of the U.S. economy is a high pace of output and input reallocation across producers.[1] The annual average job creation rate for the U.S. private sector over the last 30 years is close to 18 percent while the analogous job destruction rate is 16 percent. Evidence shows this high pace of reallocation is closely linked to productivity dynamics: resources are shifted away from low productivity producers towards high productivity producers. An open question is whether recessions have a "cleansing" impact by accelerating this productivity-enhancing reallocation. Theory suggests the nature and extent of productivity-enhancing reallocation could be fundamentally altered by the nature of the downturn. Using micro-level data, we examine how the pattern of reallocation differs in the Great Recession in terms of both intensity and the extent to which it was productivity enhancing.

Whether recessions are a period of productive winnowing or counterproductive destruction has been the subject of a long ongoing debate. Economists trace the genesis of the debate back to the Schumpeter's (1939, 1942) discussion of creative destruction. The cleansing hypothesis is that recessions are times of accelerated productivity-enhancing reallocation because it is a relatively low cost time for reallocation.[2] Alternative hypotheses highlight the potential distortions to reallocation dynamics in recessions. Such distortions could arise from many factors. For example, if credit markets are distorted in a recession, reallocation may be driven more by credit constraints and less by market fundamentals such as productivity, demand and costs. The close connection between the financial crisis and the Great Recession suggests this hypothesis might be especially relevant in the recent period.[3]

Prior research suggests the recession in the early 1980s is consistent with the cleansing

[1] We use productivity differences across producers as a placeholder more generally for differences across producers in terms of technical efficiency, demand and costs. All of these factors contribute to our empirical measure of establishment-level productivity as we discuss in Section 2.
[2] It is important to emphasize that the modern view of the "cleansing" hypothesis does not mean that recessions are necessarily welfare enhancing. The social planner may prefer to avoid cyclical variation in consumption along with the loss of activity from unemployment. But, conditional on the cycle occurring, it may be optimal to increase the pace of productivity-enhancing reallocation given the opportunity cost of time is low.
[3] Greenstone and Mas (2012) and Chodorow-Reich (2014) find a relationship between the Great Recession credit market shock and subsequent employment declines.

hypothesis.[4] Of particular relevance, Davis and Haltiwanger (1990, 1992, 1999) show job reallocation activity increased during recessions in the manufacturing sector from the late 1940s through the 1990s.[5] Extending the analysis to the entire private sector, Davis, Faberman and Haltiwanger (2006, 2012) find these patterns for manufacturing also hold for the entire private sector for the recessions in the 1990s and 2000s prior to the Great Recession.

The empirical finding that job destruction is more cyclical than job creation is directly related to the cleansing hypothesis as shown in a series of models developed in the early 1990s. In these models, the marginal cost of creating jobs is lower in recessions, so while creation falls in recessions it falls less than the rise in destruction. Possible reasons for this include: the opportunity cost of time is low in recessions (Davis and Haltiwanger (1990)), the sunk cost of job creation is increasing in the level of aggregate activity (Caballero and Hammour (1994)), or the search and matching framework is such that the marginal cost of creating a job is lower in recessions because it is easier for firms to fill jobs in slack labor markets (Mortensen and Pissarides (1994)). In all of these models, reallocation is productivity enhancing. These models provide rationales for why the intensity of reallocation may increase in recessions.

Caballero and Hammour (1996) highlight distortions, such as hold up problems and bargaining problems, which may impact incentives for job creation and job destruction over the cycle. In particular, they note if the marginal cost of creating jobs is lower in recessions, then the social planner would have job destruction rise first followed quickly by an increase in job creation in recessions. They emphasize that recessions with a rise in job destruction, a decline in job creation and only a very slow recovery in job creation are a sign of inefficiency.

Beyond the distortions emphasized by Caballero and Hammour (1996), numerous mechanisms can yield "sullying" or "scarring" effects of recessions. Barlevy (2003) develops a model building on the credit market imperfections of Bernanke and Gertler (1989). In his model, recessions are cleansing in the absence of financial constraints, but the cleansing effect can be

[4] Foster, Haltiwanger and Krizan (2001) find the 1977-82 and 1982-87 periods were times of especially intense productivity enhancing reallocation. Davis, Haltiwanger and Schuh (1996) highlight the increased intensity of reallocation during the 1982-83 recession. Recent research by Collard-Wexler and De Loecker (2013) shows this type of reallocation was responsible for much of the productivity growth in the U.S. steel industry over the last several decades.

[5] Blanchard and Diamond (1990), Davis and Haltiwanger (1990,1999) and Caballero and Hammour (2005) use VAR analysis to conduct a more nuanced and sophisticated analysis of the behavior of job reallocation over the cycle. As they emphasize, exploring the cumulative impulse response functions of job creation, destruction and - in turn - reallocation in response to an econometric specification that explicitly identifies the aggregate shocks provides a more comprehensive analysis than simple descriptive statistics of the cyclical patterns of job creation, destruction and reallocation. Given we do not conduct such analysis here, our characterization of the cyclical dynamics of creation and destruction here should be viewed as suggestive.

reversed when financial constraints are present. He shows it is possible that recessions are times of increased, but non-cleansing, reallocation.[6] In contrast, Osotimehin and Pappadà (2013) develop an alternative, related model where credit frictions have a distortionary effect on the selection of exiting firms, but they do not reverse the cleansing effect of recessions. The difference in these models is the interaction of productivity and credit constraints. Barlevy argues the most productive businesses are likely to be more subject to credit constraints. Osotimehin and Pappadà argue that the most productive firms face more forgiving net-worth exit thresholds and are more likely to face better draws of idiosyncratic productivity shocks.[7]

With these remarks as background and motivation, this paper addresses five empirical questions concerning the potential cleansing effects of the Great Recession. First, do patterns of reallocation over the business cycle change in the Great Recession? Second, is reallocation productivity enhancing? Third, does the nature of the relationship between productivity and reallocation change over the business cycle? Fourth, is the relationship between productivity and reallocation we see in earlier recessions different in the Great Recession? Fifth, what are the aggregate implications of changes in these micro-level relationships?

In the first part of our empirical analysis, we find a significant change in the responsiveness of job creation and destruction to cyclical contractions in the Great Recession relative to prior recessions. In earlier cyclical downturns, periods of economic contraction exhibit a sharp increase in job destruction and mild decrease in job creation consistent with the earlier literature. However, in the Great Recession, job creation fell by as much or more than the increase in job destruction. In this respect, the Great Recession was not a time of increased reallocation (whether productivity enhancing or not).

The second part of our analysis investigates the relationship between productivity and reallocation. We find that low productivity establishments are more likely to exit while high productivity establishments are more likely to grow. In turn, we find that the marginal impact of productivity on exit and growth changes over the cycle. For recessions before the Great Recession, the marginal impact of productivity on exit and growth increases with the magnitude of the contraction. However, this is reversed in the Great Recession. More productive establishments still have lower exit rates and higher growth rates in the Great Recession, but the

[6] Using Colombian establishment-level data, Eslava et al. (2010) present empirical evidence that the exit margin is distorted in times of financial constraints in a manner consistent with the model of Barlevy (2003). Barlevy (2002) focuses on worker matching issues as other possible reasons recessions can have sullying effects.
[7] Other mechanisms that work against cleansing have been proposed. For example, Ouyang (2009) argues recessions stifle learning opportunities important for the development of young firms.

difference in the exit and growth rates between high and low productivity establishments declines with sharp contractions. We also find that these patterns are primarily driven by establishments of young firms.[8] Finally, we find that changes in these micro-level relationships have aggregate implications. In sum, we find that the cleansing impact of earlier recessions attenuates in the Great Recession. If the cleansing effect of a recession is its 'silver lining,' we find this silver lining is tarnished in the Great Recession.

The paper proceeds as follows. The next section describes the data and measurement issues. In Section 3, we analyze job reallocation over the business cycle. We bring together reallocation and productivity measures in Section 4 to address our central question about the cleansing effect of the Great Recession. Section 5 concludes and offers ideas for future related areas of research.

2. Data and Measurement Issues

We describe our measures of reallocation and productivity in this section. We rely heavily on the growing existing literature on measuring these concepts using micro-level data. Our primary data sources are administrative, census and survey establishment-level data from the U.S. Census Bureau. These annual data cover the period from about the mid-1970s to 2011, thus enabling us to compare the Great Recession to earlier recessions.[9] We are able to examine reallocation for the entire U.S. economy, but for reasons of data availability, are constrained to the manufacturing sector when analyzing productivity. We begin by describing how we measure reallocation over the business cycle (this relates to the analysis in Section 3). We then describe how we measure productivity and reallocation in an integrated manner (this relates to the analysis in Section 4). Details about data sources and measuring productivity, weights, and job flows are given in the Appendix (in sections A-D respectively).

2.1 Reallocation

Our annual job reallocation measures for the entire U.S. economy and the manufacturing sector are from the Business Dynamics Statistics (BDS) series, which is a public-use dataset

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[8] Fort et al. (2013) find young and small firms are hit especially hard in the Great Recession. They find the decline in housing prices is important in that context.

[9] We use a variety of data sources, some of which cover different periods. The public domain BDS has job flows from 1977 to 2011. The internal version of the LBD, on which the BDS is based, is available from 1976 to 2011. The ASM/CM data we use to measure productivity is available from 1972 to 2010. We integrate this with the LBD so we can examine outcomes in the LBD from t to t+1 (starting in 1981 and looking at outcomes through 2011) using productivity through 2010. (See Appendix A.)

derived from the Longitudinal Business Database (LBD).[10] The LBD is a longitudinally linked version of the Census Bureau's business register. As such, the LBD covers all establishments with paid employees in the non-agricultural private sectors of the U.S. economy (see Jarmin and Miranda (2002)).

Measures of job flows in the BDS are consistent with the methodology from Davis, Haltiwanger and Schuh (1996) (henceforth DHS). DHS measure job creation as the employment gains from all expanding establishments including startups and job destruction as the employment losses from all contracting establishments including shutdowns. The job reallocation rate is the sum of the job creation and job destruction rates (see Appendix D).

Measures of reallocation can be calculated for various groups of establishments including establishment and firm age groups, establishment and firm size groups, establishment location (region, state) groups and establishment industry groups.[11] In addition, the measures of reallocation can be disaggregated into intensive and extensive margins. Establishment births are those establishments that did not exist in time *t*-1, but exist in time *t*; analogously establishment deaths are those establishments that exist in time *t*-1, but do not exist in time *t*. All designations of births and deaths rely upon the complete universe of information from the LBD.[12]

While most of our analysis of job flows relies on the BDS, we supplement this analysis with an alternative public-domain source of jobs flows. The Business Employment Dynamics (BED) is a longitudinal version of Bureau of Labor Statistics' (BLS) Quarterly Census of Employment and Wages. The BED covers the private economy and thus provides a quarterly analog to the annual data provided by the BDS (although coverage and measurement issues make comparability complicated).[13] The methodology for measuring job flows in the BED is essentially the same as that for the BDS.[14]

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[10] BDS data are available at http://www.census.gov/ces/dataproducts/bds/.

[11] We follow Haltiwanger, Jarmin and Miranda (2013) in our measurement and definitions of establishment and firm size and age. Age of a firm is based on the age of the oldest establishment at the time of the new firm's inception. After that, a firm ages naturally regardless of changes in composition. See Haltiwanger, Jarmin and Miranda (2013) for more on the distinction between establishments and firms in the LBD.

[12] The establishment links in the LBD are of high quality given the comprehensive administrative data underlying the LBD. DHS (1996) rely upon the ASM and CM to create measures of job creation and destruction using Census micro-level data. Using the ASM, with its rotating panels of establishments, introduces measurement complexities we avoid by using the LBD.

[13] See Davis, Faberman and Haltiwanger (2012) for a discussion of the cyclical dynamics of job flows in the BED. See Haltiwanger, Jarmin and Miranda (2011) for a discussion of the cyclical dynamics of job flows in the BDS.

[14] We use BED statistics from Davis, Faberman and Haltiwanger (2012) that have been extended back to 1990:2.

2.2 Connection Between Productivity and Reallocation

To explore the connection between productivity and reallocation, we use establishment-level data from the U.S. Census Bureau. We integrate the establishment-level LBD with establishment-level data from the Annual Survey of Manufactures (ASM) and the Census of Manufactures (CM).

Our analysis of the relationship between reallocation and productivity dynamics over the cycle is restricted to the U.S. manufacturing sector. We find job creation and destruction dynamics for manufacturing largely mimic the patterns for the whole economy. While there are some differences between the overall private and manufacturing sectors in terms of their cyclical dynamics of job flows in the Great Recession, we believe our analysis of the connection between productivity and establishment survival and growth in the manufacturing sector should be of relevance more broadly as well.

We begin by identifying all manufacturing establishments in the LBD from 1976 to 2011. We compute measures of growth and survival using DHS methodology for these establishments. Specifically, let E_{it} be employment at establishment *i* in year *t*; i.e., the number of workers on the payroll in the pay period covering March 12. The employment growth rate is $g_{it} = (E_{it} - E_{it-1}) / X_{it}$, where $X_{it} = .5*(E_{it} + E_{it-1})$.[15] In turn, we generate indicators of the components of growth – DHS growth rates for continuing establishments and indicators of establishment entry and exit. All of these measures are based on the full LBD and do not require any information from the ASM/CM data. Our measures of firm size and firm age are also derived from the full LBD and are not dependent on the ASM/CM data. We adopt the timing convention that the growth rate from March of year *t* to March of year *t*+1 represents the *t* to *t*+1 growth rate (e.g., a 2010 outcome reflects the change from March 2010 to March 2011). Thus, our analysis of the connection between productivity and reallocation reflects outcomes from *t* to *t*+1 as a function of establishment-level TFP and other measures (e.g., firm size and firm age) in period *t*. We now turn to how we construct establishment-level measures of TFP in year *t*.

To construct a measure of TFP to integrate with these LBD measures, we rely on the sub-sample of establishments present each year in either the ASM or CM from 1972-2010 to create

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[15] This growth rate measure has become standard in analyses of establishment and firm dynamics because it shares some useful properties of log differences while also accommodating entry and exit. See DHS (1996) and Tornqvist, Vartia and Vartia (1985) for discussion.

an analytic dataset for 1981-2010.[16] The CM is, in principle, the universe of establishments, but data are collected only from those establishments mailed forms. Very small establishments (where the size threshold varies by industry) have their data imputed from administrative data so we exclude those cases. The CM is collected every 5 years in years ending in "2" and "7".

The ASM is collected in all years where a CM is not collected and is a sample of roughly 50,000-70,000 manufacturing establishments. Probability of selection in to the ASM sample is a function of industry and size. Thus, in both ASM and CM years, we have a subset of establishments of the comprehensive universe from the LBD. To deal with this issue, we estimate propensity score weights for each establishment-year observation in the LBD. The weights are based on the probability an establishment is in the ASM or CM (non-administrative record cases) in a specific year. As we show in Appendix C, using such propensity score weights enables our weighted sample to replicate the size, age and industry distributions in the LBD as well as the overall patterns of employment in the LBD. Note we estimate the propensity score models separately for each year, which enables us to take into account the changing nature of our samples (e.g., CM vs. ASM years). For all of our statistical analysis using the matched ASM/CM/LBD data, we use these propensity score weights.[17]

We measure TFP at the establishment level by constructing an index in a manner similar to that used in Baily, Hulten and Campbell (1992) and a series of papers that built on that work.[18] The index is given by:

$$lnTFP_{et} = lnQ_{et} - \alpha_K lnK_{et} - \alpha_L lnL_{et} - \alpha_M lnM_{et} \tag{1}$$

where Q is real output, K is real capital, L is labor input, M is real materials, α denotes factor elasticities, the subscript e denotes individual establishments and the subscript t denotes time. Details on measurement of TFP are in Appendix B, so here we focus on the most relevant features of how these various components are measured. Operationally, we define nominal output as total shipments plus the change in inventories. Output is deflated using an industry-level measure from the NBER-CES Manufacturing Industry Database. Capital is measured

[16] While we use data back to 1972 to get the best possible capital stock measures, our analysis uses data from 1981-2010. We focus on this period since we are interested in classifying establishments based on the age of their parent firm. Our firm age measure is left-censored for firms born in or before 1976. As such in 1981 and beyond, we can consistently classify firms into age classes of less than 5 and 5 or more years old.
[17] The ASM has sample weights, which could in principle be used instead. However, the sample weighted ASM is not designed to match published totals as discussed in DHS (1996). Moreover, our method implies we are capturing the patterns of the universe LBD data. Finally, our method facilitates using the CM and ASM records in a consistent manner.
[18] Syverson (2011) provides an excellent summary.

separately for structures and equipment using a perpetual inventory method. Labor is measured as total hours of production and non-production workers. Materials are measured separately for physical materials and energy and where each are deflated by an industry level deflator. Outputs and inputs are measured in constant 1997 dollars.

We measure the factor elasticities using industry-level total factor cost shares. We could measure these factor elasticities at the establishment level, however, arguments against using an establishment-level approach can be made when factor adjustment costs exist (see Syverson (2011)). Moreover, for related reasons, Syverson (2011) notes some time averaging may be warranted at the industry-level. Accordingly, for an establishment in a given industry in period *t*, we use industry-level measures of cost shares for period *t* based on the average of the *t* and *t*-1 cost share for the factor elasticity.[19]

Given the large differences in output measures across industries (for example, steel versus food), our TFP measures need to control for industry differences in any comparison over industries. We do this by creating measures of (log) TFP that are deviations from the industry-by-year average. We refer to this as TFP in the remainder of the paper but it should be interpreted as the deviation of establishment-level TFP from the industry-by-year average.

As noted above, our measure of productivity is a revenue measure. This means differences in establishment-level prices are embedded in our measure of productivity. Unfortunately, the Census Bureau does not collect establishment-level prices. However, as Foster, Haltiwanger and Syverson (2008) (henceforth FHS) have shown, it is possible to back-out the establishment-level price effects for a limited set of products in Economic Census years. FHS create a physical quantity measure of TFP removing the establishment-level price for establishments producing a set of 11 homogeneous goods (for example, white pan bread). The within-industry correlation between revenue and physical productivity measures in FHS is high (about 0.75). However, FHS also find there is an inverse relationship between physical productivity and prices consistent with establishments facing a differentiated product environment. In addition, FHS find establishment-level prices are positively related to idiosyncratic demand shocks. As such, our measure of establishment-level productivity should

[19] As discussed in Syverson (2011), there are numerous alternative ways to measure factor elasticities (e.g., estimation methods using either IV or proxy methods to address endogenous factors), but these alternative methods tend to produce similar establishment-level TFP measures (even if they produce somewhat different factor elasticities). We also consider industry-level cost shares averaged over our entire sample and obtain very similar results. Our approach is related to the Divisia/Tornqvist index number approach but this latter approach is focused on an index of TFP growth over time. Our focus is on generating a relative productivity measure across establishments within years.

be interpreted as reflecting both idiosyncratic technical efficiency and demand factors. However, we only capture the idiosyncratic demand factors as they translate into establishment-level prices. It is important to emphasize that it is only idiosyncratic demand shocks (not aggregate or industry level) demand shocks that are potentially captured by our TFP measure given that our measure deviates from industry by year means.

Summary statistics of our integrated establishment-level sample are provided in Table 1. We have roughly 2.2 million establishment-year observations from 1981-2010. We measure growth rates and survival rates for all of these establishments based on the LBD from t to t+1. In Table 1, the growth rate for incumbent establishments is negative.[20] By design, this growth rate does not include the contribution of entry. The growth rate for continuing establishments is about -1 percent and the slightly higher exit rate (8 percent) compared to entry rate (7 percent) implies the overall growth rate inclusive of entry (not reported) is about -2 percent. TFP represents the deviation from industry-year means so by construction has a mean of zero. The within industry-by-year dispersion in TFP is similar to that reported in Syverson (2004). The cyclical variable we focus on (called "Cycle," the change in the state-level unemployment rate from the CPS) has a mean around zero but with substantial variation.[21] It is not uncommon for individual states to experience changes in unemployment of 0.03 in a given year in the Great Recession. About 20 percent of establishments belong to young firms, and the Great Recession dummy applies to less than 10 percent of our establishment-year observations.

We also show summary statistics with establishments classified into young and mature (based upon the age of the firm). We find growth rates for young (excluding startups) are lower than for mature businesses, but this reflects a substantially higher growth rate for continuing young and a substantially higher exit rate for young.

3. Did Reallocation Dynamics Change in the Great Recession?

In this section, we present results of our analysis of the patterns of job creation and job destruction over the cycle. We start by examining job flows using data from the BDS series,

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[20] These statistics use the propensity score weights to adjust the sample, but are not activity weighted.

[21] We use this measure because it allows for variation at national and state levels and is highly correlated with other measures indicative of the business cycle. Correlations between the change in the national unemployment rate and other cyclical indicators are as follows: GDP growth (-0.92); net employment growth (0.93), and change in employment-to-population (over 16 years old) ratio (-0.95). We prefer measures of the cycle that correspond to measures of change and growth as opposed to measures that capture deviations of levels from trends because the change and growth measures are much more highly correlated with our outcomes of interest (i.e., employment growth). For example, at the national level the correlation between the Hodrick-Prescott filtered unemployment rate and net employment growth is only -0.23.

which provides annual job flow statistics for the entire U.S. private sector. Panel A of Figure 1 shows the job creation and job destruction rates for the U.S. economy from 1981-2011. The figure also includes the change in the unemployment rate.[22] It is apparent that job destruction tends to rise and job creation tends to fall during periods of increasing unemployment. Interestingly, it appears this pattern changed in the Great Recession. Job destruction did rise sharply in the 2008 to 2009 period, but what is more striking is the sharp fall in job creation that starts in 2007 and persists through 2010. We also note job flows exhibit a downward trend – a point we return to below.

As both a cross check and to explore higher frequency data, we use job creation and destruction series from the BED statistics, which also cover the U.S. private sector. Panel B of Figure 1 shows *quarterly* job creation and job destruction rates with the change in the unemployment rate for the period 1990:2 to 2012:1. The quarterly numbers reinforce the message from the annual data that recessions are periods in which job destruction rises and job creation falls. Again, however, job creation falls sharply in 2007 and stays low. The downward trend in job flows is even more pronounced in the BED. An advantage of the BED is that it is more current: Figure 1B shows the slow recovery from the Great Recession through the first quarter of 2012 is due to anemic job creation rather than job destruction staying persistently high. Other related data sources (e.g., the Job Openings and Labor Turnover Survey, JOLTS) confirm this pattern has continued past the first quarter of 2012.

Job creation is as low during the Great Recession as during any period in the last 30 years (see Figure 1). Moreover, job reallocation (creation plus destruction) is at its lowest point in 30 years during the Great Recession and its immediate aftermath. Comparing the Great Recession to the early 1980s recession: job reallocation is 28 percent in 2009 in contrast to 35 percent in 1983 (both time periods are when job destruction peaked and are measured using March-to-March BDS data). These patterns are driven in part by the substantial downward trends in job flows evident in both the BDS and the BED.[23] It is well beyond the scope of this paper to explore the determinants of the declining trends in job flows, however, it is clear downward trends are

[22] The change in the unemployment rate is the March-to-March change to match the timing of our job flows series. All measures of growth and change (e.g., job flows and unemployment rate) are measured as percents in this section, while they are measured as fractions in other parts of the paper. We use rates in percents in this section since it facilitates discussion of trends.

[23] Figure E.1 in the Appendix depicts the Hodrick-Prescott trends in the job flows that clearly depict the downward trends.

important so we take them into account in our analysis.[24]

To assess the changing pattern of job creation during cyclical downturns, we begin with a simple calculation quantifying the fraction of the changes in net employment accounted for by changes in job creation during periods of net contraction. For each episode of net contraction lasting for one or more periods, we cumulate the net employment losses during the episode (in percentage terms) starting from the beginning of each episode. We also cumulate the change (typically a reduction) in job creation over the same episode. These cumulative changes permit computing the fraction of net employment contraction accounted for by the reduction in job creation.[25] A simple example helps illustrate the calculation. Suppose over four consecutive periods net growth is {0, -4, -6, 0}, job creation is {15, 14, 13, 15} and job destruction is {15, 18, 19, 15}. There is a net contraction during periods 2 and 3. The cumulative net employment decline in periods 2 and 3 is -10 and the cumulative decline in job creation is -3 so the fraction is 0.3.[26]

We sum up these cumulative changes from each cyclical contraction for two sub-periods (pre- and post-Great Recession) and compute the fraction for each of these changes.[27] Using this cumulative change per episode largely mitigates concerns about trends since the cumulative changes are from the start of each cyclical episode.[28] One limitation of this approach when using the national BDS and BED series is the relatively small number of periods over which to make these calculations. To overcome this limitation, we also compute this using state-level job flow series. We then take the average of these fractions across all states.

Table 2 shows the share of the decline in net employment accounted for by declines in job creation during net contractions. The share is substantially below 0.5 for net contractions prior to the Great Recession. Thus, most of the net decline during contractionary periods prior to the Great Recession is accounted for by a rise in job destruction rather than a fall in job creation. In contrast, this share rises substantially above 0.5 in the post-2007 period; during the Great Recession, most of the net decline is accounted for by a decline in job creation.

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[24] See Davis et al. (2007), Davis and Haltiwanger (2014), Decker et al. (2014a, 2014b), and Hyatt and Spletzer (2013) for discussions of determinants of declining trends in job flows.

[25] By construction, overall net contraction is accounted for by the cumulative reductions in job creation and the cumulative increases in job destruction.

[26] Notice it is the cumulative decline in job creation from just prior to the start of the current contraction (that is, the job creation is -1 in period 2 and -2 in period 3 relative to job creation just prior to the start of the current contraction).

[27] This is equivalent to taking the weighted average of the per episode fractions where the weight is the cumulative net change for the episode.

[28] We cumulate first differences in net employment and job flows so we are effectively detrending.

We shed further light on these patterns by taking advantage of state-level variation in the covariance between cyclical indicators and the job flows. We consider simple descriptive regressions relating job flows to a cyclical indicator and a dummy variable for the Great Recession period interacted with the cyclical variable. For this purpose, we use state-level changes in the unemployment rate.[29] Since we see a negative trend in job flows, we include a linear trend in our specifications.[30] The results are shown in Table 3. The specifications have a main effect of the cyclical indicator and an interaction effect. As such, the overall effect for the Great Recession is the sum of the main and interaction effect. During the Great Recession, the relationship between the change in unemployment and job creation becomes more negative, it becomes less positive with job destruction, and its relationship with the reallocation rate shifts from its usual positive relationship to a negative one.

We also explore the extent to which earlier recessions are different from each other (see Table E.1 in the Appendix). In particular, we estimate specifications equivalent to Table 3 where we include a dummy for the 1981-83 recession interacted with the cyclical indicator as well as the Great Recession dummy interacted with the cyclical indicator as in Table 3.[31] We find no evidence the 1981-83 recession differs from other recessions prior to the Great Recession in terms of the nature of the covariance between job flows and the cycle. In contrast, the Great Recession is different. Reallocation fell rather than increased in the Great Recession.

Earlier studies emphasize the large decline in job creation in the Great Recession is driven by a decline in job creation for young businesses (see Fort et al. (2013)). Defining young firms as those less than 5 years old, Figure 2 shows patterns of job creation and destruction at the *establishment* level by firm age class (young and mature).[32] Job creation fell substantially especially among the very young businesses.[33]

Overall, our evidence points towards the cyclical covariance of job creation and destruction exhibiting different patterns in the Great Recession. Prior to the Great Recession,

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[29] We consider other cyclical indicators such as the change in the employment–to-population ratio (population over age 16) and obtain very similar results.

[30] In unreported results we find similar patterns using the national sample in spite of the relatively sparse number of observations. We also find the patterns are robust to using alternative detrending methods.

[31] These are simple specifications with main effects and interaction effects so the overall effect for the early 1980s recession is the main effect plus the interaction effect for the early 1980s recession. The same remarks apply to the Great Recession.

[32] This analysis is based on establishments classified by the characteristics of the parent firm.

[33] We repeat the same type of simple descriptive regressions as in Table 3 by these age categories and find young businesses have greater sensitivity to the cyclical indicator in terms of both job creation and job destruction. We also find job creation for young businesses fell more with the increase in unemployment in the Great Recession than in prior recessions (see Table E.2 in the Appendix).

destruction is more cyclically sensitive and reallocation rises in cyclical downturns. These patterns are consistent with the reallocation timing and cleansing models of Davis and Haltiwanger (1990), Caballero and Hammour (1994) and Mortensen and Pissarides (1994). However, in the Great Recession these patterns changed. Job creation fell much more substantially and job destruction rose less resulting in little, if any increase, in reallocation (the BDS estimates actually yield a decline in reallocation in the Great Recession). The trend decline in job flows also plays a role in these dynamics. The low job creation and reallocation rates in the Great Recession and its aftermath are driven by both trend and cyclical factors.

These patterns do not provide direct information about whether the greater intensity of reallocation in prior recessions is actually productivity enhancing nor whether the slowdown in reallocation in the Great Recession also exhibited changes in the nature of reallocation. To address these questions, we need to explore the relationship between productivity and reallocation.

As a final point for this section, we also find that the patterns for the private sector tend to hold for the manufacturing sector (shown in Appendix Figure E.2). This is relevant since our analysis of the cyclical relationship between productivity and reallocation is confined to the manufacturing sector where we can measure TFP at the micro level. The different patterns of recessions are especially apparent in comparing the 2001 downturn and the Great Recession. During the 2001 downturn, there was a sharp rise in job destruction with relatively little response of job creation in the manufacturing sector. In contrast, in the Great Recession, while job destruction also exhibits a substantial increase, there is a much more notable decline in job creation. When we conduct the same type of exercise as in Table 2 for manufacturing, we find the share of cumulative net losses during contractions accounted for by job creation is equal to 0.13 in contractions prior to the Great Recession and equal to 0.28 post-2007.[34] In manufacturing, variation in job destruction still dominates but variation in job creation plays a substantially larger role in the Great Recession.

4. Did Cleansing Effects Change in the Great Recession?

Existing research shows a tight connection between reallocation and productivity dynamics: exit is much more likely for low productivity establishments while establishment growth is increasing in productivity. A large fraction of industry-level productivity growth is

[34] We calculate these fractions using periods of net contraction for the overall economy.

accounted for by this reallocation of outputs and inputs from low productivity to high productivity businesses.[35] Canonical models of firm dynamics by Jovanovic (1982), Hopenhayn (1992), Hopenhayn and Rogerson (1993) and Ericson and Pakes (1995) provide a structure for heterogeneous firm dynamics models where firms are subject to idiosyncratic productivity, demand and cost shocks, which impact their growth and survival.

In the analysis that follows, we use empirical specifications consistent with these models to examine whether there is a connection between productivity-enhancing reallocation and the business cycle. We use a simple regression model linking the growth and survival dynamics of incumbent establishments to productivity. We examine entry indirectly by focusing on young versus mature businesses. Complementing our analysis of the dynamics of young firms, we provide some descriptive analysis of where entrants fall in the productivity distribution at the point of entry.

4.1 Growth and Survival of Incumbents

Our core specification is given by:

$$Y_{es,t+1} = \lambda_s + \lambda_{t+1} + \beta * TFP_{est} + \gamma * Cycle_{s,t+1} + \delta * TFP_{est} * Cycle_{s,t+1} + X'_{est}\Theta + \varepsilon_{es,t+1} \tag{2}$$

where *e* is establishment, *s* is state, *Y* is a set of outcomes, *TFP* is total factor productivity deviations from industry by year means, and *Cycle* is the change in the relevant state unemployment rate from *t* to *t+1*.[36] There are three outcomes (all measured from *t* to *t+1*): "Overall Growth" (continuers+exit), "Exit," and "Conditional Growth" (conditional on survival, that is, continuers).[37]

In considering the specification, timing is important. We explore the determinants of growth and survival from *t* to *t*+1 based on the productivity of the establishment in period *t* and the business cycle conditions from *t* to *t*+1 (the change in state level unemployment from the

[35] For example: Baily, Hulten, and Campbell (1992); Campbell (1998); Baily, Bartelsman and Haltiwanger (2001); Bartelsman and Doms (2001); Foster, Haltiwanger and Krizan (2001, 2006); Syverson (2011).

[36] We report in the Appendix three robustness checks for the cyclical indicator, all of which produce results very similar to those reported in the main text. First, we use specifications without year effects so that variation in the national cycle is used (Table E.3). Second, we use specifications with year effects but without state effects (Table E.4). Third, we use the change in the employment-to-population (age 16+) ratio as the cyclical indicator (Table E.5).

[37] One potential limitation of our approach in using outcomes for manufacturing establishments is they may be less sensitive to local business cycle conditions than establishments in other sectors. We find there is a strong relationship between the outcomes of manufacturing establishments and local business conditions. Note, Syverson (2004) finds many manufactured goods are shipped less than 500 miles. In future work, it would be interesting to consider how the patterns vary by sector (and in turn the local nature of the market for the goods).

CPS).

We estimate this specification for 1981-2010 pooling all years with year effects and controlling for establishment characteristics (including establishment size, firm size and state effects).[38] The inclusion of year effects implies we are exploiting state-specific variation in the cycle and that we have abstracted from any of the trend issues (at least national trends) discussed in the previous section. While this is a reduced form specification, it is broadly consistent with the specifications of selection and growth dynamics from the literature. A common prediction from the models discussed above is low productivity plants are more likely to exit. Similarly, the adjustment cost literature for employment dynamics predicts, conditional on initial size, plants with positive productivity shocks are more likely to grow (e.g., Cooper, Haltiwanger and Willis (2007)). In terms of the empirical literature, there is already much evidence that high productivity establishments are more likely to survive and grow (e.g., Syverson (2011)). Our innovation is to consider how these effects vary over the cycle and in turn across different cycles.

The unit of observation is the establishment in a given state and year. Since some key right-hand side variables vary only at the state-year level, standard errors are clustered at the state-level. We focus on results using clustering at the state level since Angrist and Pischke (2009) and Arellano (1987) suggest clustering at the state-level given potential serial correlation in the state-level regressors. Clustering errors at the state-year level or the state level yields similar results.

To examine the impact of the Great Recession, we expand Equation (2) to include effects of the Great Recession:

$$\begin{aligned} Y_{es,t+1} = {} & \lambda_s + \lambda_{t+1} + \beta * TFP_{est} + \gamma * Cycle_{s,t+1} + \delta * TFP_{est} * Cycle_{s,t+1} + \chi * GR_{t+1} * TFP_{est} \\ & + \mu * GR_{t+1} * Cycle_{s,t+1} + \phi * GR_{t+1} * Cycle_{s,t+1} * TFP_{est} + X_{est}'\Theta + \varepsilon_{es,t+1} \qquad (3) \end{aligned}$$

where *GR* is a dummy for the Great Recession taking on values of 1 in years 2007-09.[39]

Results of these regressions are shown in Table 4. We first consider specifications without interactions with the Great Recession (columns 1, 3 and 5). In these specifications, the cross-sectional impact of productivity on growth and survival (when the change in the unemployment rate is zero) is given by the first row of columns 1, 3 and 5. Consistent with

[38] For firm size effects, we use firm size classes in period *t*. For establishment size effects, we have considered both establishment size classes and log employment at the establishment level in period *t*. We obtain very similar results for both cases, and in the paper we use log employment at the establishment level.
[39] *GR* indicates outcomes from March 2007 to March 2010.

earlier studies, we find establishment-level productivity is positively related to growth and negatively related to exit in the cross section. All of these effects are statistically significant.

To assess quantitative significance, Figure 3 depicts the implied differences in growth and survival between an establishment one standard deviation below the within industry-year mean and an establishment one standard deviation above the industry-year mean for the main TFP effect (independent of the cycle so *Cycle*=0). For now, we focus on the bars in Figure 3 labeled "All". The difference in overall growth rates between an establishment one standard deviation below and above the mean is about 11 percentage points, the analogous difference in exit rates is 4 percentage points, and the difference in the growth of survivors is 3 percentage points. Comparing the magnitudes of the difference for overall growth with the difference for conditional growth, it is evident the predicted difference in overall growth rates is largely accounted for by the predicted difference in exit rates.[40]

Returning to Table 4, we also find growth and survival of manufacturing establishments are related to local business cycle conditions. Increases in the state-level unemployment rate are associated with declines in growth and increases in exit. All of these effects are statistically significant and large in magnitude.

Of primary interest, we find the relationship between productivity and reallocation is enhanced in business cycle contractions. The positive impact of productivity on overall growth and negative impact of productivity on exit are both increased in magnitude during periods with increases in state-level unemployment. Both of these effects are large in magnitude and statistically significant. We find the point estimate for this interaction effect is positive for the growth of continuing establishments, but is not statistically significant at conventional levels. As we discuss below, this is sensitive to permitting effects to vary with firm age.

Did these patterns change in the Great Recession? Columns 2, 4 and 6 of Table 4 speak to this question. We are particularly interested in the interaction effect of TFP and the cycle. First, we find the magnitude of the estimated interaction effect between TFP and the cycle is larger for the period prior to the Great Recession than what we find in columns 1, 3 and 5 when we pool all recessions together. This pattern is especially notable for the overall growth and exit specifications. Driving this is the estimated 3-way interaction between TFP, the cycle and the

[40] Note the "exit" outcome in Table 4 and Figure 3 is from a linear probability model so there is no simple aggregation of the survival growth and exit outcomes to obtain the overall growth outcome. This requires translating exit into job destruction from exit. The difference between the overall growth and survival growth yields an estimate of the latter (appropriately weighting survival growth for the share of continuing establishments).

Great Recession which is reported in the last row of columns 2, 4, and 6. For overall growth, we find the 3-way estimated effect is negative and statistically significant. Observe as well the magnitude of the overall interaction between TFP and the cycle is negative in the Great Recession (adding 2.182 and -2.961). Thus, instead of the cycle enhancing the impact of TFP on overall growth, it tends to diminish it on the margin in the Great Recession. A similar pattern is observed for exit. The estimated 3-way interaction effect is positive and larger in magnitude than the 2-way interaction effect of TFP and the cycle. Instead of the cycle enhancing the impact of TFP on exit, it tends to diminish it on the margin in the Great Recession. For growth of continuing establishments, we find less systematic patterns. It appears the 3-way interaction for overall growth is being driven mostly by the exit margin.

There are other estimated interactions of interest in columns 2, 4 and 6. In particular, we find the impact of the cycle is even more severe in terms of its impact on growth and survival in the Great Recession. We also find the main effects of TFP (independent of the cycle) on growth and survival are slightly enhanced in the Great Recession (although only statistically significant for exit).

We use the same type of exercise as in Figure 3 to quantify how the relationship between productivity, growth and survival changes with the cycle. Figure 4 depicts such exercises for the overall growth and exit outcomes. We focus on overall growth and survival since we obtain statistically significant effects for the interaction between the effects of TFP and the cycle for these outcomes.[41] The leftmost bar labeled "Normal" (zero change in unemployment) is taken from Figure 3. The remaining bars of each figure show how these outcomes vary with the cycle. A "Mild" contraction is a 1 percentage point increase in state-level unemployment, a "Sharp" contraction is a 3 percentage point increase in state-level unemployment, and "GR" is for the period 2007-09 (reflecting outcomes from March 2007 to March 2010).

We find the difference in overall growth between high and low productivity establishments increases substantially when unemployment rises in periods before the Great Recession. In a sharp contraction, the difference in overall growth rates exceeds 15 percentage points (see Figure 4A). The Great Recession modifies these patterns. The difference in growth rates between high and low productivity establishments is still large in the Great Recession but rather than increasing with unemployment, it falls with increases in unemployment. In a mild contraction in the Great Recession, the difference in growth rates between high and low

[41] For completeness, we show the results for continuing establishments in Appendix Figure E.3.

productivity establishments is about 13 percentage points. For a sharp contraction, this falls to about 12 percentage points.

Closely related patterns are exhibited in Figure 4B for the exit margin. In cyclical contractions before the Great Recession, the difference in exit rates between low and high productivity establishments rises with larger increases in unemployment (note that in Figure 4B we use the difference in exit rates between *low* and *high* productivity establishments). However, in the Great Recession, this pattern reverses. While there is still a substantially higher probability of exit of low productivity businesses during the Great Recession, this difference declines with larger increases in unemployment.[42]

We now turn to exploring whether these patterns vary by firm age. As before, we denote as "Young" establishments that are part of young firms and call the remaining establishments of mature firms, "Mature".[43] The results of these regressions are shown in Table 5. We find that the general patterns for the full sample hold for both "Young" and "Mature" (compare columns 1, 3 and 5 in Table 5 to those in Table 4). However, the quantitative magnitudes are substantially larger for the establishments of young firms. To see this, we start by returning to Figure 3. For young businesses, we find that the difference in growth rates for an establishment one standard deviation below and above mean productivity is about 17 percentage points. In contrast, the analogous difference for mature establishments is about 10 percentage points. The exit and growth rate of continuers for young establishments are also substantially more sensitive to productivity than mature establishments.

Table 5 shows establishments of young firms are also more sensitive to the cycle, and the interaction effect of the cycle and productivity is larger in magnitude for establishments of young firms and is statistically significant for all three outcomes. The significance of the estimated 2-way interaction between TFP and the cycle for the growth of continuing young establishments is especially notable since it contrasts with the results of Table 4 where we could not detect a statistically significant relationship. Table 5 helps account for this as we find that the 2-way interaction effect between TFP and the cycle is actually negative (although not significant) for mature continuing establishments. Apparently, cleansing effects on this margin (growth of continuing establishments) are present only for young businesses.

Did these patterns change in the Great Recession? For the 3-way interaction effect of

[42] In Appendix Table E.6 we show the results in Table 4 are broadly similar if we exclude the 1981-83 recession suggesting our results are not simply driven by differences between the 1981-83 recession and the Great Recession.
[43] Results are similar when we use measures of "Young" that rely on establishment age.

interest between TFP, the cycle and the Great Recession, we find point estimates largely consistent with those for the full sample but with less systematic statistical significance. Part of the challenge here is that the number of establishments from young firms is only about 20 percent of the overall sample and the 3-way interactions are focusing on a specific 3-year period (2007-09). Based on the point estimates for establishments of young firms, we find that the 3-way interaction effect between TFP, the cycle and the Great Recession tends to offset the 2-way interaction effect between TFP and the cycle. However, while the patterns are systematic, they are not precisely estimated. For mature establishments, we find smaller 3-way interaction estimates but they still tend to systematically offset the 2-way interaction of TFP and the cycle. We know from Table 4 that when pooled we obtain large, statistically significant effects for the 3-way interaction that offset the 2-way interaction. We are pushing the data hard in seeking to identify differential 3-way interaction effects by firm age – especially given the group that is more sensitive to the cycle (young) has relatively small samples for the 2007-09 period.

We illustrate the predictions from Table 5 in Figure 5 in the same manner as Figure 4. We focus on overall growth for the sake of brevity.[44] Figure 5 shows the differences in growth rates between high and low productivity establishments are much larger for establishments of young as opposed to mature firms. For example, the difference in growth rates between high and low productivity establishments of young firms is over 15 percentage points while the difference for establishments of mature firms is generally around 10 percentage points. This differential grows for both young and mature but especially for young during periods of rising unemployment prior to the Great Recession. For young, it grows to over 25 percent in a sharp contraction. During the Great Recession, this differential is only at 21 percent for a sharp contraction. While appropriate caution is needed for the latter interaction with the Great Recession given the lack of statistical precision, it suggests the result that the Great Recession is less productivity enhancing is being driven disproportionately by young establishments.

A possible concern about our results is that we have made no adjustments for cyclical variation in capacity utilization in our measures of TFP. It is well known that capacity utilization is procyclical (see Basu and Fernald (2001)) likely due to capacity utilization increasing in times of higher demand. Thus, standard aggregate measures of TFP that are not adjusted for time varying capacity utilization are spuriously procyclical. This concern is substantially mitigated in

[44] The results for exit and growth of continuing establishments are shown in Appendix Figures E.4 and E.5 respectively. The much larger response of young continuing establishments to TFP and to the interaction of TFP and the cycle is evident in Figure E.5.

our setting because our measures of TFP are deviations from industry-by-year means. If specific years or even specific industries within years are hit especially hard in a recession by demand shocks, our measure of TFP abstracts from any common time variation in capacity utilization at the industry by year level. Still, it may be that when a specific industry is hit especially hard in a downturn not all plants in the industry are equally impacted leading to idiosyncratic variation in capacity utilization over the cycle. We address this issue in a sensitivity analysis and find these concerns are not driving our results. In this analysis, we include as extra controls the energy to capital ratio at the plant level both separately and interacted with all variables in the same way as TFP. Using the energy to capital ratio at the plant level is a common way to capture variation in capacity utilization (see Burnside, Eichenbaum and Rebelo (1995)). The results show that our findings on the marginal impact of productivity over the cycle on growth and survival are robust to including these additional controls (see Appendix Table E.7). We find high energy-to-capital ratio plants are less likely to exit and more likely to grow consistent with predictions but this does not change our results on productivity.

4.2 Where Do Entrants Fit In?

The specifications of growth and survival we use in the prior section, while not derived explicitly from a structural model, are consistent with theoretical models of firm dynamics in the literature. An equivalent specification for entry would require capturing the decision rules of potential entrants, which is well beyond the scope of this current paper. Instead, we conduct a simple descriptive analysis of where entrants fit in the productivity distribution relative to incumbents and how this changes over the cycle. For this purpose, we estimate a simple descriptive linear probability specification based upon classifying establishments in any given year into two groups: new entrants (establishments in the first year of operation) and existing establishments (establishments with activity in prior years).

The specification has as the left-hand side variable *entry* equal to one if the establishment is a new entrant and equal to zero otherwise. On the right-hand side, we include TFP in the current year, a measure of the *Cycle* (in this case from t-1 to t since the designation of entry is for establishments that entered between t-1 and t), and the interaction. We also include a specification where we permit these relationships to differ in the Great Recession using a *GR* dummy (again being careful to treat the timing differently since this outcome is between t-1 and t).

We report results for this descriptive regression in Table 6. We find higher productivity establishments are slightly less likely to be entrants. The estimated effect is statistically significant given our sample size but is quantitatively small. Moving from one standard deviation below the (within industry) mean to one standard deviation above mean implies a difference in the likelihood of being an entrant of less than half a percent. Thus entrants have slightly lower productivity than incumbents. This finding is consistent with findings in Foster, Haltiwanger and Krizan (2001) and FHS (2008). In terms of FHS (2008), recall this pattern may reflect lower prices for entrants compared to incumbents (given our TFP measure is a measure of TFPR rather than TFPQ).

Not surprisingly, the likelihood an establishment is an entrant is lower in times of rising unemployment in the state. In terms of the interaction between TFP and the cycle, we find a positive and significant point estimate suggesting entrants in contractions are relatively more productive than in expansions. Again, however, this effect is relatively small. For an increase in unemployment of 3 percentage points, the probability a high productivity establishment is an entrant is positive but very small. Moving from one standard deviation below mean productivity to one standard deviation above mean productivity yields a one tenth of one percent higher probability that an establishment is an entrant during a period of a sharp contraction. We find little evidence these patterns changed substantially in the Great Recession. We know from earlier work that job creation from entry fell substantially in the Great Recession (e.g., Fort et al., 2013). This is consistent with the patterns here given the large negative coefficient on the cyclical variable. It is a bit surprising that the interaction between *GR* and the cycle is not statistically significant (although it is negative, consistent with earlier work).

4.3 Aggregate Implications

The analysis of the relationship between productivity and reallocation above is based on the relationship between growth, survival and productivity at the establishment level. A strength of this approach is the rich set of controls we are able to use while focusing on within state variation in the cycle over time to identify the effects of interest. A limitation of the analysis is that it is difficult to draw inferences about aggregate consequences for productivity. A full analysis of the latter is beyond the scope of this paper but in this section we conduct a counterfactual exercise to shed light on the aggregate consequences.

Much of the literature on the aggregate relationship between productivity and reallocation revolves around the extent to which resources are shifted away from less productive to more productive establishments (see Syverson (2011) for a recent survey). Our micro analysis is very much about such shifts, a fact which we now exploit in a simple counterfactual exercise to provide some perspective on aggregate implications. In each year we first compute the following base year index using the actual data:

$$P_t = \sum_i \theta_{it} P_{it}$$

where θ_{it} is the employment weight for plant *i* in period *t* and P_{it} is plant-level productivity (deviated from the industry-year mean). Then we use the model to generate a counterfactual index given by:

$$P_{t+1}^C = \sum_i \theta_{it+1}^C P_{it}$$

where $\theta_{it+1}^C$is the predicted employment share for plant *i* in period *t* based upon the estimated model. We compute the predicted employment share using base year employment levels and the predicted growth rates in employment from the model.[45] We measure the gains from reallocation as $P_{t+1}^C - P_t$. We conduct this exercise in each year and then take time averages of these differences depending on different assumptions for the counterfactual (where the assumptions differ in terms of the assumed state of the cycle). [46]

Given that we use plant-level productivity measured as deviations from within industry-by-year means, this calculation yields an estimate of the implied increase in within industry productivity from reallocation effects alone. Moreover, since the plant-level distribution of productivity is held constant (in each year) for this exercise, the change only reflects the interaction of the predicted changes in the distribution of employment with where plants sit in the productivity distribution.

Figure 6 shows the results of this exercise. The bar labeled “Normal” implies that in a year with no change in the unemployment rate, the average increase in productivity from reallocation effects from one year to the next across incumbents is about 2.1 log points. During Mild and Sharp contractions prior to the Great Recession, this contribution increases to 2.4 and

[45] For this purpose we use all of the terms in the model involving TFP, the cycle and the GR dummies.
[46] The index of productivity is an employment-weighted average of establishment-level productivity. In this respect it is related to the indices used in Baily, Hulten and Campbell (1992), Griliches and Regev (1995), Olley and Pakes (1996) and Foster, Haltiwanger and Krizan (2001). Much of the work using activity-weighted averages of establishment-level TFP uses either output or composite input weights. We do not have that information for our counterfactual (we use the LBD to generate outcome measures for the counterfactual) so we are restricted to using the activity measures in our outcome measures – namely employment. Foster, Haltiwanger and Krizan (2001) show these activity-weighted indices are similar using output, input or employment weights.

2.9 log points respectively. However, during Mild and Sharp contractions in the Great Recession (which can be thought of as the effect across different states), the reallocation contribution is 2.3 and 2.1 log points respectively. Consistent with our micro evidence, the contribution of reallocation to this aggregate index of establishment-level productivity decreases in the Great Recession.

These estimates of the contribution of reallocation are large relative to those in the literature. In accounting decompositions such as those in Foster, Haltiwanger and Krizan (2001) and Foster, Haltiwanger and Syverson (2008), reallocation effects account for up to half of industry-level productivity growth using similar activity-weighted establishment-level productivity as indices of industry-level productivity. In these papers, this type of average industry index grows by about 1 log point per year so that half of this is substantially below the greater than 2 log point effects we are capturing. However, a strength of our current approach relative to this existing literature is that our counterfactual exercise focuses on the reallocation effects induced by productivity differences. That is, in this earlier literature, the accounting decompositions capture the contribution of reallocation of activity across establishments regardless of the source of that reallocation.[47] The work of Foster, Haltiwanger and Syverson (2008, 2013) emphasizes that much reallocation is induced by demand side effects as opposed to productivity effects. Our TFPR measure captures some but hardly all of the demand side effects identified in this recent work. Instead, our counterfactual exercise is based on the reallocation that is directly linked to productivity differences. Taking our results at face value yields a substantial contribution to productivity growth from productivity difference induced reallocation.[48]

5. Conclusions and Future Work

We address the question "Was the Great Recession a cleansing recession?" by building up five related facts. First, we show reallocation in the Great Recession differs markedly from earlier recessions. Job creation falls much more substantially than in prior recessions and job destruction rises less than in prior recessions – taken together they yield less of an increase (or

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[47] In terms of the above exercise, this is equivalent to using actual θ_{it+1} in calculating the gains from reallocation.
[48] Our counterfactual exercise cannot provide a full accounting of overall industry-level productivity growth. The ASM is not well-suited for capturing the within establishment productivity growth that is a critical part of the overall growth. High frequency ASM data can measure the cross sectional distribution of TFP within industries in a given year, but does not provide a high-quality measure of within-establishment productivity growth given the ASM's sample limitations. The ASM is not well suited for longitudinal analysis of plants, thus our longitudinal outcomes are derived from the LBD.

even a decline) in the intensity of reallocation. Second, we find reallocation is productivity enhancing. Less productive establishments are more likely to exit, while more productive establishments are more likely to grow. Third, we show these patterns are enhanced in recessions prior to the Great Recession. Fourth, we show reallocation is less productivity enhancing in the Great Recession as contractions become more severe. The gap in growth rates and exit rates between high productivity and low productivity businesses decreases rather than increases with larger increases in unemployment in the Great Recession. Fifth, we find that the implied increases in aggregate (industry-level) productivity indices from productivity-induced reallocation are substantial, with even larger effects in sharp contractions prior to the Great Recession and smaller effects in sharp contractions in the Great Recession.

Our analysis is mostly descriptive – evaluating how the patterns and nature of reallocation change over the cycle and how they differ in the Great Recession. We do not directly address why the Great Recession is different. As such, our contribution is much more about what happened than why it happened. The obvious next step is to explore why the patterns are different. A clear candidate is the role of the financial collapse. Our finding that the patterns change more for young businesses is at least suggestive that the financial collapse (which arguably hit young firms much harder) is relevant. But to provide convincing evidence, we need to find ways to integrate direct measures of the financial collapse at the firm or at least regional level into the type of analysis we have conducted here.[49]

This paper raises questions which bear looking into in future research. One interesting question concerns heterogeneity of recessions in general. In comparing the Great Recession to earlier recessions in our productivity analysis, we group all of the earlier recessions for which we have data into one category in our main analysis. Much of the thinking about cleansing recessions was motivated by the patterns seen in the 1981-83 recession. The 1981-83 recession has a big surge in destruction and exits of low productivity establishments followed by a big surge in creation as early as 1984. That recession is very different from the relatively mild recessions of 1991 and 2001.[50] We do sensitivity analysis that suggests our results are not driven by the differences between the 1981-83 recession and the Great Recession, but there is much

[49] Fort et al. (2013) present evidence that the fall in housing prices is important for understanding the especially large decline of young businesses in the Great Recession.

[50] Our descriptive analysis in Section 3 shows these shallower recessions did not differ much from the early 1980s recession in terms of the covariance between job flows and the cycle. The 1991 and 2001 recessions differ in terms of the severity of the recessions but the covariance between job flows and changes in unemployment are similar across the 1981-83, 1991 and 2001 recessions.

room for further research in this area. In particular, investigating differences across recessions taking into account the different driving forces of recessions would be a promising area for future research. This would be one way to help understand why the Great Recession looks different in terms of its reallocation dynamics.

Another interesting area for future research is to explore the implications of the declining trend in job flows exhibited in the U.S. over the last few decades for productivity growth. Both the BDS and BED show pronounced downward trends in job flows and thus the pace of reallocation. Since we find reallocation is productivity enhancing in general (ignoring the cycle), the obvious question is whether this has implications for long run trend productivity growth in the U.S.

Finally, we note a core limitation of our current analysis is that we study the relationship between productivity and reallocation only for the manufacturing sector. While manufacturing is interesting and important, much of the changing patterns of job reallocation in terms of trends and the cycle are driven by other sectors. Our focus on manufacturing is driven by data limitations. There are sources that can be used for measuring productivity (even TFP) for establishments and firms in other sectors – but this will require addressing a variety of challenges in terms of measurement and methodology. The high pace of reallocation in non-manufacturing sectors and the changing patterns of reallocation suggest addressing such challenges would have substantial payoffs.

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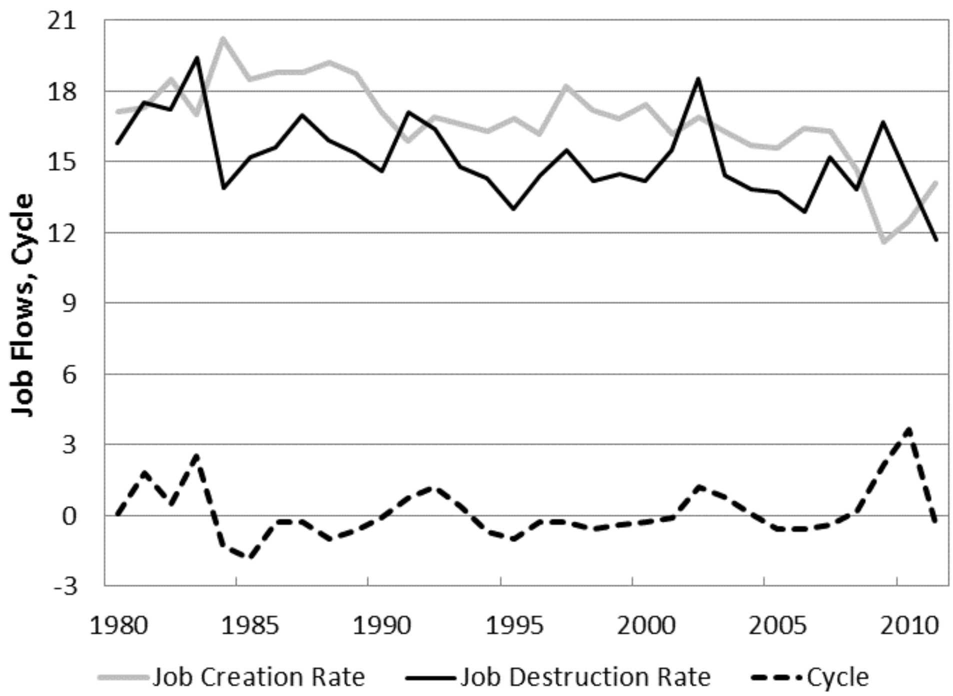
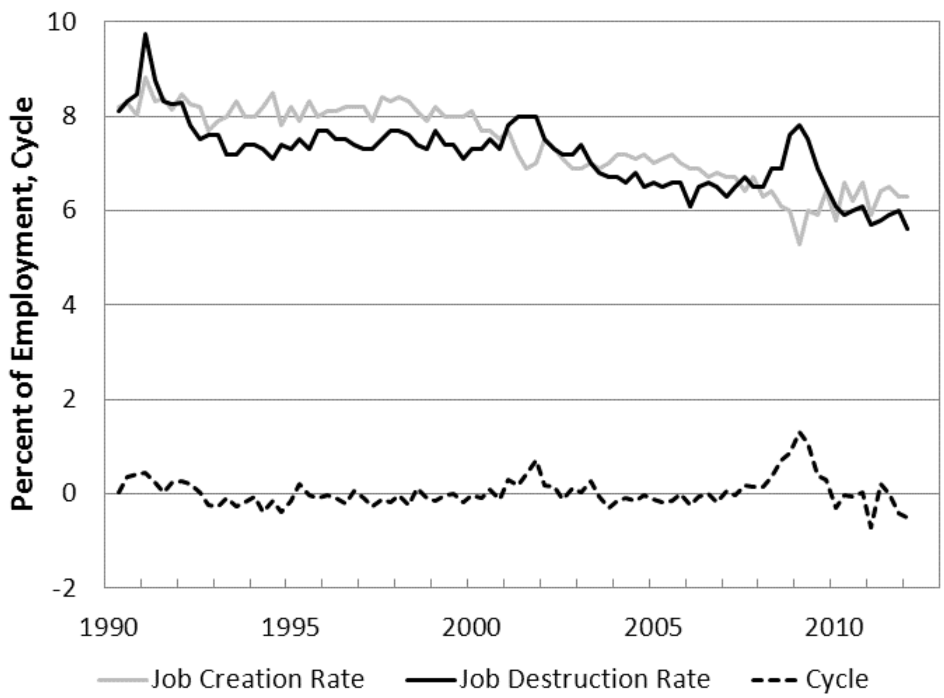
Figure 1. Job Flows and the Business Cycle

A. Annual, 1980-2011



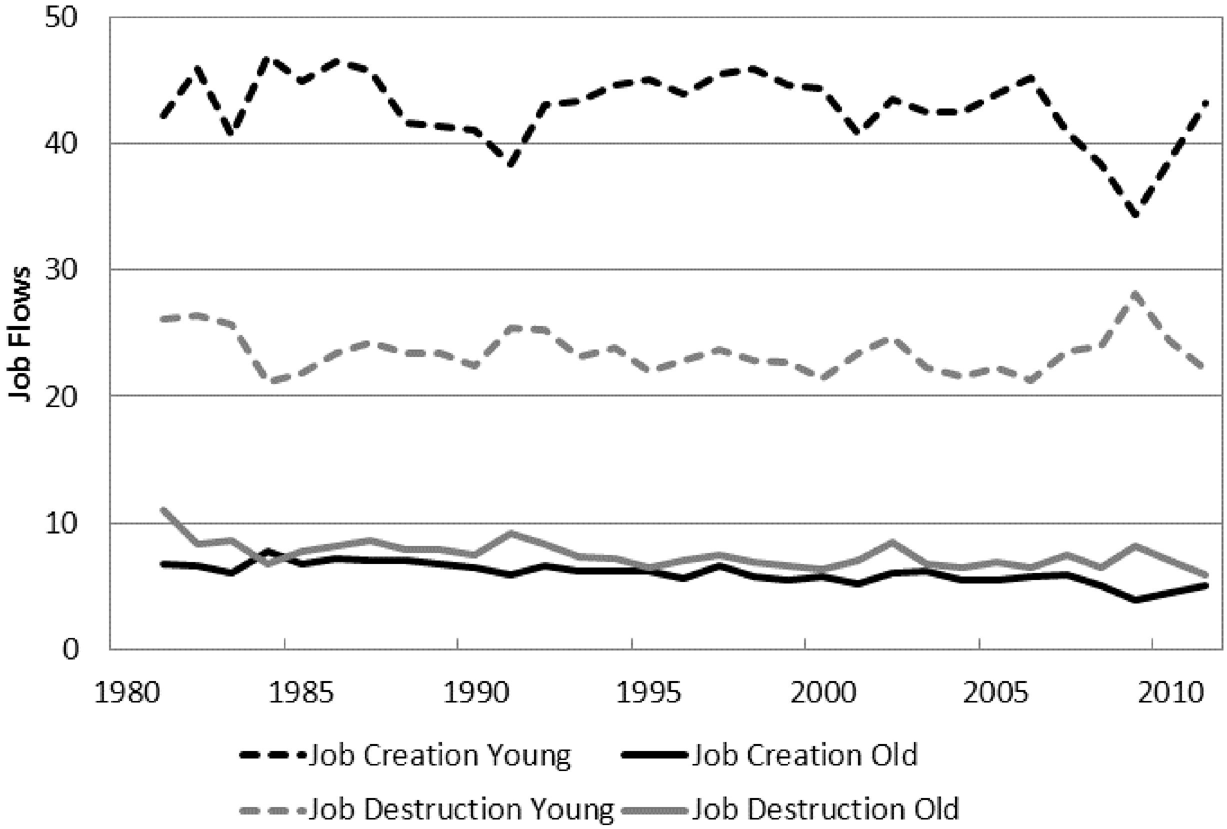
B. Quarterly, 1990:2-2012:1



Source: Authors calculations using the BDS (Annual), BED (Quarterly) and CPS.

Note: Cycle is the change in the unemployment rate.

Figure 2. Job Flows by Age, 1981-2011



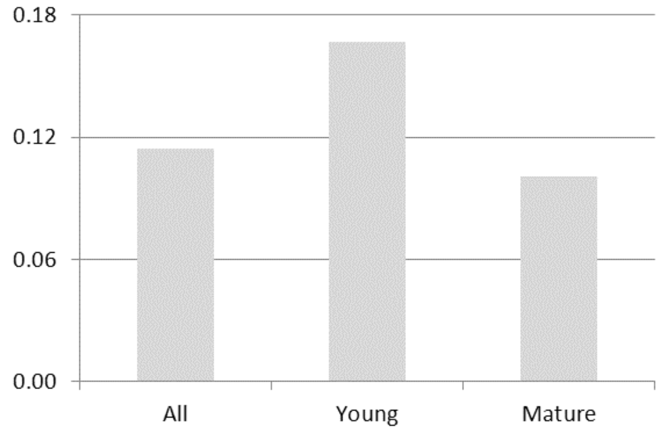
Source: Authors' calculations on the BDS.

Notes:

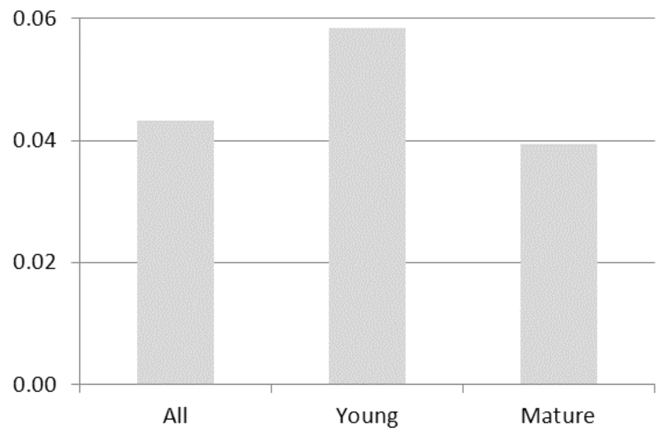
1. Young is for establishments owned by firms less than 5 years old. Mature is for establishments owned by firms 5 or more years old.
2. Job flows are establishment-based and are classified by firm age characteristics.

Figure 3. Differences in Growth Rates Between High and Low Productivity Establishments, Normal Times

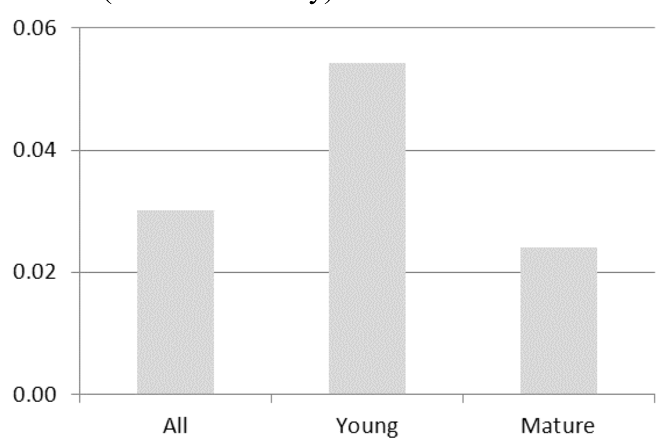
Panel A. Overall Growth (Continuing + Exiting Establishments)



Panel B. Exit Rates



Panel C. Conditional Growth (Continuers Only)

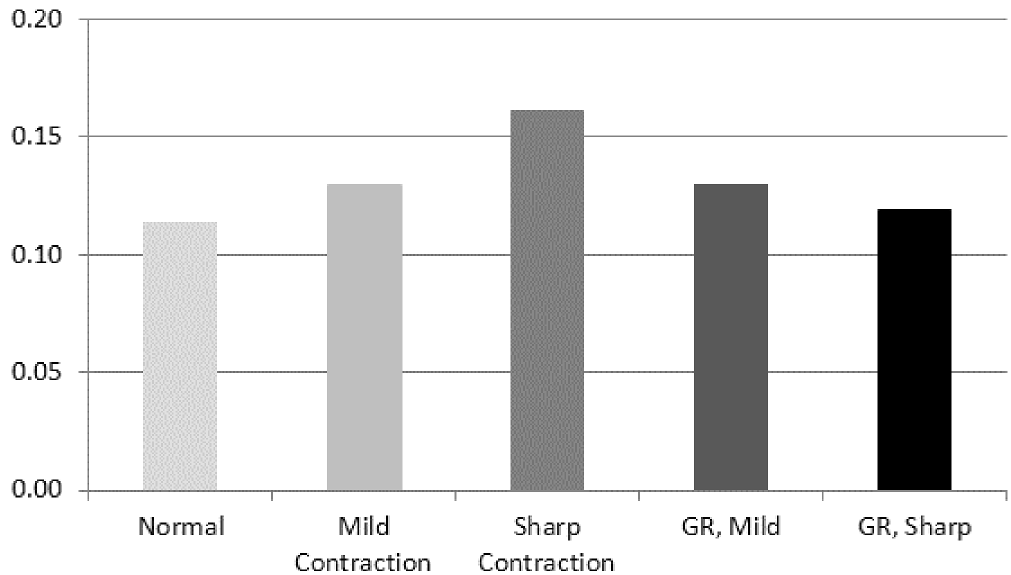


Source: Authors' calculations on the ASM, CM and LBD.

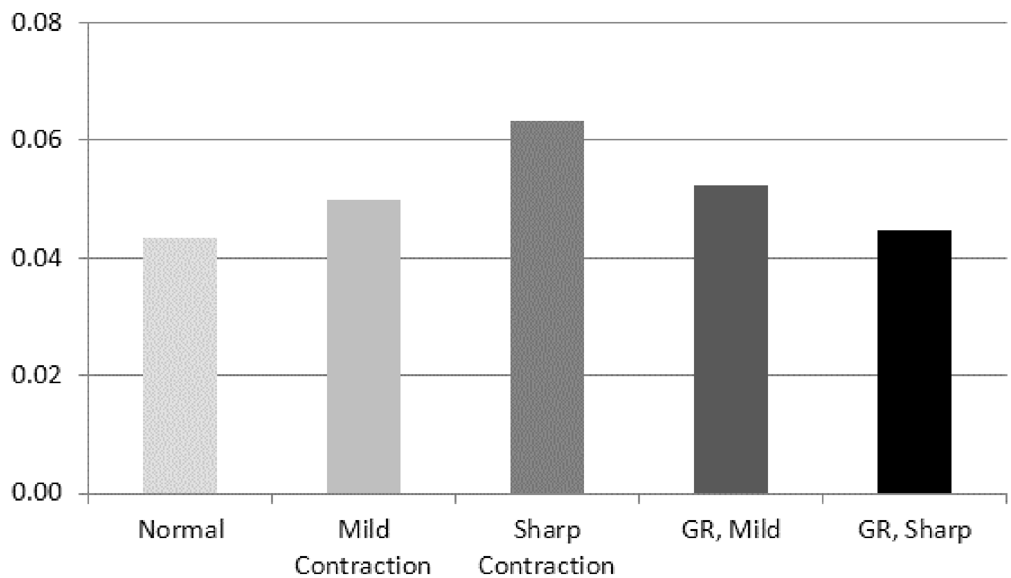
Depicted is the predicted difference in growth rates (panels A and C, high minus low) and the predicted difference in probability of exit (panel B, low minus high) between an establishment one standard deviation above industry-by-year mean productivity and an establishment one standard deviation below industry-by-year mean productivity. Normal is zero change in state-level unemployment.

Figure 4. Differences in Growth and Exit Rates Between High and Low Productivity Establishments Over the Business Cycle

Panel A. Overall Growth and Productivity (Continuing + Exiting Establishments)



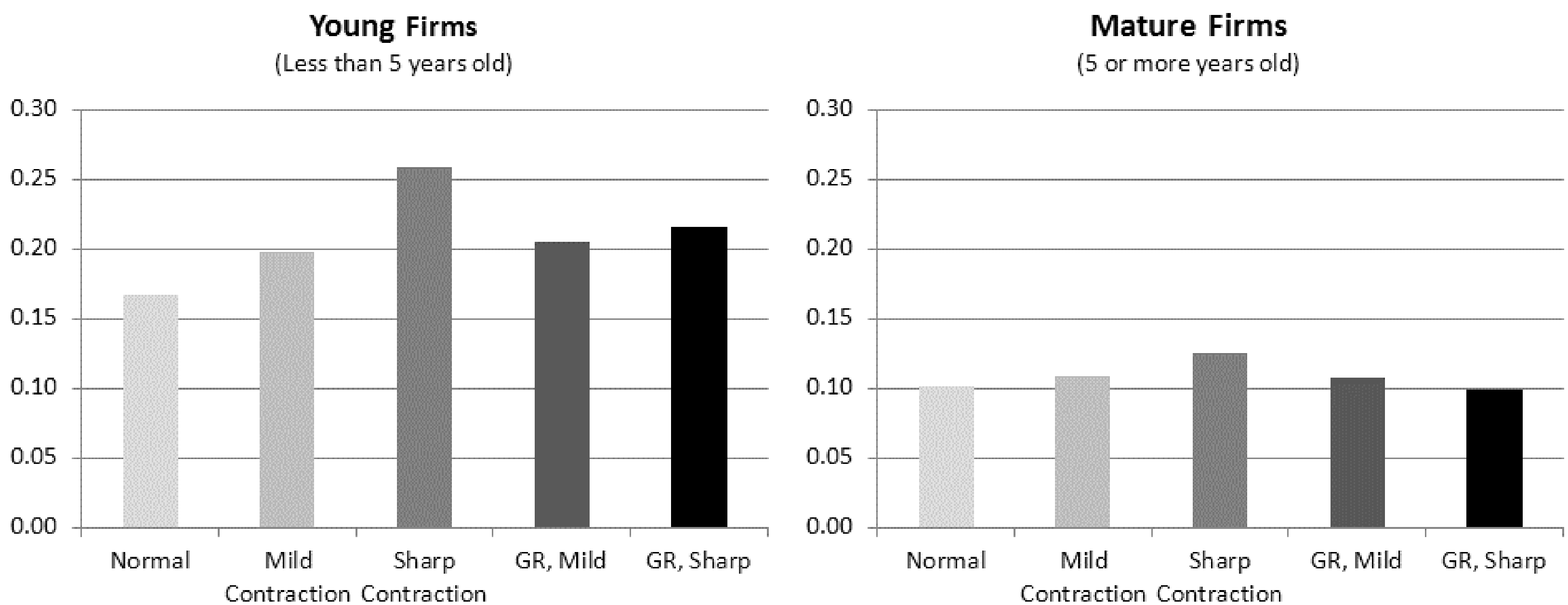
Panel B. Exit Rates



Source: Authors' calculations on the ASM, CM and LBD.

Notes: Depicted is the predicted difference in growth rates (panel A, high minus low) and the predicted difference in probability of exit (panel B, low minus high) between an establishment one standard deviation above industry-by-year mean productivity and an establishment one standard deviation below industry-by-year mean productivity. Normal is zero change in state-level unemployment, mild contraction is 1 percentage point increase in state level unemployment, sharp contraction is 3 percentage point increase in state-level unemployment, GR is for period 2007-09.

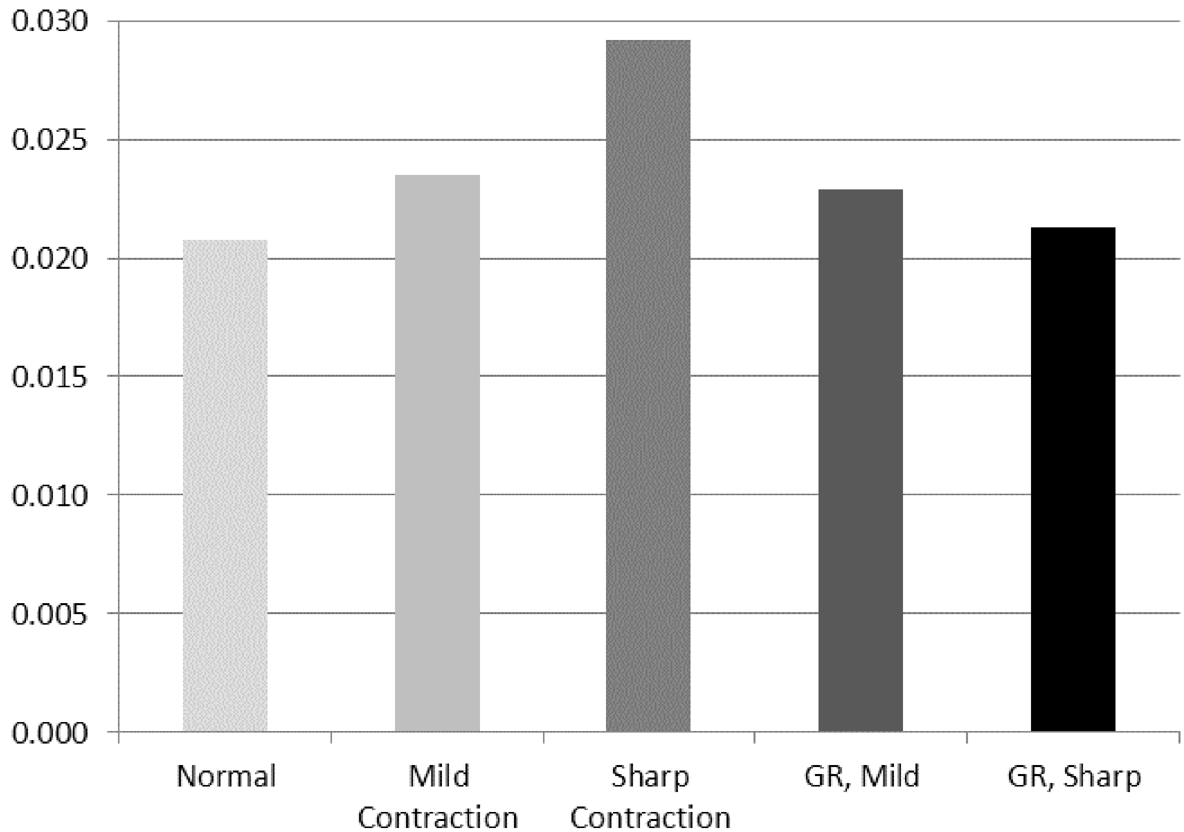
Figure 5. Differences in Overall Growth Rates (Continuing + Exiting Establishments) Between High and Low Productivity Establishments Over the Business Cycle: By Firm Age



Source: Authors' calculations on the ASM, CM and LBD.

Notes: Depicted is the predicted difference in growth rates (high minus low) between an establishment one standard deviation above industry-by-year mean productivity and an establishment one standard deviation below industry-by-year mean productivity. Normal is zero change in state-level unemployment, mild contraction is 1 percentage point increase in state level unemployment, sharp contraction is 3 percentage point increase in state-level unemployment, GR is for period 2007-09.

Figure 6. Predicted Contribution of Reallocation to Aggregate (Industry-Level) Productivity



Source: Authors' calculations from estimated models.

Table 1. Descriptive Statistics, ASM/CM/LBD Matched Sample

	Mean	Standard Deviation
Overall Growth Rate (Continuers + Exit)	-0.17	0.65
Young	-0.26	0.85
Mature	-0.15	0.59
Establishment Exit	0.08	0.27
Young	0.15	0.35
Mature	0.07	0.25
Conditional Growth Rate (Continuers Only)	-0.01	0.38
Young	0.04	0.49
Mature	-0.02	0.35
Establishment Entry	0.07	0.25
TFP	0.000	0.360
Young	-0.011	0.353
Mature	0.003	0.362
Cycle	0.0004	0.0107
Young	0.19	0.39
GR	0.09	0.28
Years	1981-2010	
N (millions)	2.2	

Source: Authors' calculations on the ASM, CM and LBD.

Notes:

1. Statistics use propensity score weights to make the sample representative of the LBD. Statistics are not activity weighted.
2. Employment growth and exit are measured from period t to period t+1. Rates are in fractions (not percents).
3. TFP is the deviation of establishment-level log TFP from its' industry-year mean in year t so the mean is, by construction, equal to zero.
4. Cycle is the state-year change in the unemployment rate from t to t+1. Rates are in fractions (not percents).
5. Young is a dummy variable equal to one for establishments that belong to firms less than 5 years old.
6. GR is a dummy variable equal to one for years from 2007 to 2009.

Table 2. Share of Change in Net Employment Growth Due to Change in Job Creation in Periods of Net Contraction

Period	National		State
	BDS (Annual)	**BED (Quarterly)**	**BDS (Annual)**
Pre-Great Recession	0.21	0.28	0.39
Post-2007	0.61	0.59	0.65

Source: Authors' calculations on the BDS and BED.

Notes:

1. The calculations take advantage of the identity that Net = Job Creation – Job Destruction. For periods of net contraction lasting one or more periods, the cumulative change in net employment growth and cumulative change in job creation are calculated over the entire consecutive period of net contraction. In turn, these cumulative changes are cumulated further within the periods in the table. The share is the fraction of the overall cumulative change in net employment growth over the specified period accounted for by the overall change in job creation over the specified period.
2. For BDS, Pre-Great Recession is 1981-2007, Post-2007 is 2008-2011. For the BED, Pre-Great Recession is 1990:2-2007:3, Post-2007 is 2007:4-2012:1. As noted, these statistics are only calculated for periods with net employment growth less than zero. For example, this is 2007:4-2010:1 for the BED.
3. For the BDS National annual there are only 6 years of net contraction with only 2 years in the post 2007 period. For the BED quarterly, there are 22 quarters of net contraction with 9 quarters in the post-2008 period. For the BDS State Annual there are 393 state-year observations with net contraction with 112 state-year observations with net contractions in the post-2007 period.

Table 3. Job Flows and Change in the Unemployment Rate at the State-Level (Annual), 1981-2011

	Job Creation Rate	**Job Destruction Rate**	**Reallocation Rate**
Cycle	-0.631^{***}	1.194^{***}	0.563^{***}
	(0.046)	(0.053)	(0.068)
GR*Cycle	-0.371^{***}	-0.421^{***}	-0.793^{***}
	(0.079)	(0.079)	(0.128)
Trend	-0.168^{***}	-0.136^{***}	-0.304^{***}
	(0.010)	(0.011)	(0.020)
N	1,581	1,581	1,581

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations on the BDS.

Notes:

1. GR is a dummy variable equal to one for years from 2008 to 2010 (job flows from March 2007 to March 2010).
2. Cycle is the *state*-year change in the unemployment rate.
3. All specifications include state fixed effects.
4. Standard errors in parentheses are clustered at the state level.

Table 4. Reallocation and Productivity over the Business Cycle

	Overall Growth Rate (Continuers + Exiters)		Exit		Conditional Growth Rate (Continuers Only)	
	(1)	(2)	(3)	(4)	(5)	(6)
TFP	0.157***	0.159***	-0.060***	-0.060***	0.041***	0.042***
	(0.006)	(0.006)	(0.003)	(0.003)	(0.003)	(0.003)
Cycle	-3.307***	-2.961***	0.671***	0.497***	-2.143***	-2.128***
	(0.459)	(0.483)	(0.176)	(0.179)	(0.247)	(0.286)
TFP*Cycle	1.542**	2.182**	-0.655***	-0.927***	0.494	0.534
	(0.643)	(0.862)	(0.226)	(0.265)	(0.412)	(0.567)
GR*TFP		0.030		-0.018*		-0.005
		(0.023)		(0.011)		(0.011)
GR*Cycle		-3.116**		1.581***		-0.126
		(1.349)		(0.523)		(0.770)
GR*TFP*Cycle		-2.961*		1.466**		0.066
		(1.619)		(0.684)		(0.764)
Year FE	yes	yes	yes	yes	yes	yes
State FE	yes	yes	yes	yes	yes	yes
Firm Size Class FE	yes	yes	yes	yes	yes	yes
N (millions)	2.2	2.2	2.2	2.2	2.1	2.1

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations on the ASM, CM and LBD.

Notes:
1. Regressions are weighted by propensity score weights. Weight calculation is described in the Appendix.
2. Standard errors (in parentheses) are clustered at the state level.
3. Employment growth and exit are measured from period t to period t+1. Regression for exit is a linear probability model where exit=1 if the establishment has positive activity in period t but no activity in period $t+1$.
4. TFP is the deviation of establishment-level log TFP from its' industry-year mean in year t.
5. GR is a dummy variable equal to one for years from 2007 to 2009 (reflecting outcomes from March 2007 to March 2010).
6. Cycle is the state-year change in the unemployment rate from t to t+1.
7. Establishment size (log employment in t) is included as a control.

Table 5. Reallocation and Productivity over the Business Cycle By Firm Age

	Overall Growth Rate (Continuers + Exiters)		Exit		Conditional Growth Rate (Continuers Only)	
	(1)	(2)	(3)	(4)	(5)	(6)
Young	-0.059***	-0.054***	0.050***	0.049***	0.047***	0.050***
	(0.005)	(0.005)	(0.002)	(0.002)	(0.003)	(0.003)
TFP*Mature	0.138***	0.139***	-0.054***	-0.055***	0.034***	0.033***
	(0.007)	(0.007)	(0.003)	(0.003)	(0.003)	(0.003)
TFP*Young	0.237***	0.236***	-0.085***	-0.083***	0.075***	0.077***
	(0.013)	(0.015)	(0.006)	(0.006)	(0.006)	(0.007)
Cycle*Mature	-2.590***	-2.487***	0.345**	0.230	-2.047***	-2.183***
	(0.401)	(0.402)	(0.143)	(0.141)	(0.232)	(0.270)
Cycle*Young	-6.626***	-5.274***	2.196***	1.775***	-2.578***	-1.878***
	(0.988)	(1.152)	(0.407)	(0.463)	(0.412)	(0.455)
TFP*Cycle*Mature	0.674	1.112	-0.429*	-0.720***	-0.031	-0.193
	(0.620)	(0.733)	(0.234)	(0.235)	(0.354)	(0.538)
TFP*Cycle*Young	3.886**	4.336**	-1.147*	-1.088	2.476**	2.811**
	(1.568)	(2.016)	(0.649)	(0.759)	(1.030)	(1.110)
GR*TFP*Mature		0.015		-0.010		-0.005
		(0.029)		(0.014)		(0.007)
GR*TFP*Young		0.046		-0.030		-0.004
		(0.076)		(0.034)		(0.042)
GR*Cycle*Mature		-1.685		1.234**		0.769
		(1.268)		(0.505)		(0.758)
GR*Cycle*Young		-8.627***		2.940***		-4.152***
		(2.318)		(0.934)		(0.907)
GR*TFP*Cycle*Mature		-1.708		1.162		0.686
		(1.691)		(0.759)		(0.657)
GR*TFP*Cycle*Young		-3.566		0.965		-0.999
		(4.585)		(1.934)		(2.115)
Year FE	yes	yes	yes	yes	yes	yes
State FE	yes	yes	yes	yes	yes	yes
Firm Size Class FE	yes	yes	yes	yes	yes	yes
N (millions)	2.2	2.2	2.2	2.2	2.1	2.1

* p < 0.10, ** p < 0.05, *** p < 0.01
Source: Authors' calculations on the ASM, CM and LBD.

Notes: See notes to Table 4. Young (Mature) is establishments that belong to firms less than (greater than or equal to) 5 years old.

Table 6. Entry and Productivity over the Business Cycle

	Establishment Entry	
	(1)	**(2)**
TFP	-0.006***	-0.006***
	(0.002)	(0.002)
Cycle	-0.388***	-0.376***
	(0.136)	(0.142)
TFP*Cycle	0.274***	0.239**
	(0.075)	(0.103)
GR*TFP		0.006*
		(0.004)
GR*Cycle		-0.176
		(0.504)
GR*TFP*Cycle		-0.088
		(0.199)
Year FE	yes	yes
State FE	yes	yes
Firm Size Class FE	yes	yes
N (millions)	2.2	2.2

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations on the ASM, CM and LBD.

Notes:
1. Regressions are weighted by propensity score weights. Weight calculation is described in the Appendix.
2. Standard errors (in parentheses) are clustered at the state level.
3. Entry is measured from *t*-1 to *t*. Regression is linear probability model with entry=1 if this is first year of operation of establishment.
4. TFP is the deviation of establishment-level log TFP from its' industry-year mean in year *t*.
5. GR is a dummy variable equal to one for years from 2008 to 2010 (given *t*-1 to *t*).
6. Cycle is the state-year change in the unemployment rate from *t*-1 to *t*.
7. Establishment size (log employment in *t*) is included as a control.

Appendix to “Reallocation in the Great Recession: Cleansing or Not?”

A. Establishment-Level Data

A.1. Longitudinal Business Database

The Longitudinal Business Database (LBD) is a census of non-agricultural business establishments and firms with paid employees in the U.S. The LBD is comprised of survey and administrative records and is currently available from 1976-2011.[51] The LBD contains establishment-level information on payroll, employment, industry and geography.

We use the LBD to create our three outcome measures: overall growth (employment growth for continuers + exiters), establishment exit, and conditional growth (employment growth for continuers only). These outcome measures are created from t to t+1. For example, establishment exit = 1 if the establishment is active (has positive employment) in period t and is not active in period t+1.

Our measures of establishment and firm age are created using the LBD. Establishment age is calculated as the current year minus the first year the establishment appears in the LBD with positive employment. We calculate firm age as the age of the oldest establishment in the firm in the first year the firm appears in the LBD with positive employment. Establishments and firms are “young” if they are less than 5 years old and “mature” if they are 5 years old or older.

We also use the LBD to create a measure of firm size. We sum up the employment of all establishments in the firm to get firm size. The firm size class variable is created as shown below in Table A.1. We include this variable for firm size fixed effects in our regressions.

[51] The LBD and other establishment-level data used in this paper are available for use by qualified researchers with approved projects in secure Census Bureau Research Data Centers.

Table A.1. Firm Size Class Definition

Definition	Firm Size Class
Firm Employment < 250	1
250 ≤ Firm Employment < 500	2
500 ≤ Firm Employment < 1000	3
Firm Employment ≥ 1000	4

A.2. Census of Manufactures

The Census of Manufactures (CM) collects data from manufacturing establishments every 5 years in years ending in “2” and “7”. All manufacturing establishments are sent forms except for very small establishments (less than five employees). Payroll and employment data for these very small establishments is available from administrative records. The Census Bureau uses the administrative data to impute other data items for these “administrative records cases.” We drop administrative records cases from our dataset. We use CM data from 1972-2007.

The CM includes information on industry, geography, outputs and inputs. We use the CM in conjunction with the Annual Survey of Manufactures (described below) to calculate establishment-level total factor productivity (TFP). Our TFP calculation methodology is described in Section B of this Appendix. We also use state and industry data from the CM.

A.3. Annual Survey of Manufactures

The Annual Survey of Manufactures (ASM) is collected in all non-CM years. The Census Bureau surveys roughly 50,000-70,000 manufacturing establishments in the ASM. We use ASM data from 1973-2010. The ASM is a series of 5-year panels, with new panels starting in years ending in “4” and “9”. Probability of selection into the ASM sample is a function of industry and size.

Like the CM, the ASM also includes information on industry, geography, outputs and inputs. We link data from the ASM and CM over time to calculate establishment-level TFP. Our TFP calculation methodology is described in Section B of this Appendix. We also use state and industry data from the ASM.

B. Measuring Establishment-Level Total Factor Productivity (TFP)

In calculating TFP, our primary data sources are the 1972-2010 ASM and CM data. We supplement these data with industry-level data from the Bureau of Economic Analysis (BEA), the Bureau of Labor Statistics (BLS), and the NBER-CES Manufacturing Industry Database.

B.1. Output

We calculate real establishment-level total output, Q_{et}, as shown in (B1).

$$\text{If the resulting } Q_{et} \text{ is positive, then } Q_{et} = \frac{(TVS_{et}+DF_{et}+DW_{et})}{PISHIP_{it}}$$

$$\text{else } Q_{et} = TVS_{et}/PISHIP_{it} \tag{B1}$$

where TVS_{et} is the total value of shipments for establishment e in year t, DF_{et} is the difference between the values of end-of-year and beginning-of-year finished goods inventories for establishment e in year t, DW_{et} is the difference between the values of end-of-year and beginning-of-year work-in-progress inventories for establishment e in year t, and $PISHIP_{it}$ is the industry-level shipments deflator.[52] Note, when components of *DF* or *DW* are missing, they are set to zero.

B.2. Labor

Labor, TH_{et}, is measured as total hours, calculated as shown in (B2).

$$\text{If } SW_{et} > 0 \text{ and } WW_{et} > 0 \text{ then } TH_{et} = (PH_{et} * SW_{et})/WW_{et}$$

$$\text{else } TH_{et} = PH_{et} \tag{B2}$$

where SW_{et} is the total annual payroll for establishment e in year t, WW_{et} is the payroll of production workers for establishment e in year t and PH_{et} is the number of hours worked by production workers for establishment e in year t.

B.3. Capital

We use the perpetual inventory method to calculate capital stocks where possible – separately for structures and equipment. Specifically:

[52] Industry-level deflators are at the 4-digit SIC industry level prior to 1997 and at the 6-digit NAICS industry level thereafter. The *PISHIP*, *PIMAT* and *PIEN* deflator are from the NBER-CES Manufacturing Industry Database.

$$K_{e,t+1} = \left(1 - \delta_{i,t+1}\right)K_{et} + I_{e,t+1} \tag{B3}$$

where *I* denotes investment, and δ denotes the depreciation rate (at the industry level *i*). To use the perpetual inventory method, we must initialize capital stocks and have uninterrupted investment data. Given the panel nature of the ASM and the varying availability of capital stock data, we apply the perpetual inventory method backwards through time in some cases.

We initialize capital stocks in the earliest possible year using book values adjusted for the ratio of real to book value of capital at roughly the 2-digit SIC or 3-digit NAICS level. The ratio of real to book value of capital is derived from BEA data.[53] We deflate capital expenditures using investment price deflators from the BLS at the 2-digit SIC or 3-digit NAICS level.

When we cannot initialize capital stocks using the method described above, we use a methodology similar to Bloom et al. (2013), imputing initial capital stocks for a relatively small number of additional cases (less than half a percent) using I/K ratios. Specifically, if the establishment was in the prior CM, we impute the initial capital stock for the establishment using the ratio of investment to the book value of capital stock (I/K ratio) in the prior CM. If the establishment was not in the prior CM, we use the industry-level I/K ratio, calculating a separate ratio for young (less than 5 years old) establishments.[54]

B.4. Materials

Real establishment-level non-energy materials costs, M_{et}, are calculated as shown in (B4).

$$M_{et} = (CP_{et} + CR_{et} + CW_{et})/PIMAT_{it} \tag{B4}$$

where CP_{et} is the cost of materials and parts for establishment *e* in year *t*, CR_{et} is the cost of resales (products bought and sold without further processing) for establishment *e* in year *t*, CW_{et}

[53] SIC codes are used prior to 1997 and NAICS codes are used thereafter. BEA provides only SIC/NAICS industry descriptions. These descriptions are converted into SIC codes (roughly SIC2, but some SIC3 groups) or NAICS codes (roughly NAICS3, but some NAICS4 groups) using a concordance provided in "Local Area Personal Income and Employment Methodology" (April 2010) [www.bea.gov/regional/pdf/lapi2008/lapi2008.pdf].

[54] We use a hybrid approach for a small number of cases. We try to avoid abrupt jumps in the capital stock at the establishment level when the needed imputation is for a one-year data gap. These gaps occur due to ASM panel rotation (e.g., establishment is in CM but not current ASM – then selected for subsequent ASM). In this method, we consider two alternative capital stock measures. One uses the I/K ratio imputation as noted in the text. The other uses perpetual inventory to calculate the capital stock for the establishment filling in gap years in the establishment's data assuming the establishment had zero investment in the gap year. If this latter "gap" capital stock number is larger than the capital stock calculated using our version of the Bloom et al. (2013) method, we use it.

is the cost of work done for the establishment by others on the establishment's materials for establishment e in year t and $PIMAT_{it}$ is the industry-level materials deflator.

We calculate real establishment-level energy costs as shown in (B5).

$$E_{et} = (EE_{et} + CF_{et})/PIEN_{it} \tag{B5}$$

where EE_{et} is the cost of purchased electricity for establishment e in year t, CF_{et} is the cost of purchased fuels consumed for heat, power or the generation of electricity and $PIEN_{it}$ is the industry-level energy deflator.

B.5. Industry-Level Cost Shares

We calculate industry-level cost shares for each input using publicly available data from the BLS and the NBER-CES Manufacturing Industry Database. Our calculated cost shares are at the 4-digit SIC level prior to 1997 and at the 6-digit NAICS level thereafter.

We obtain the following industry-level cost measures from the NBER-CES data: capital expenditures on equipment (*EQUIP*); capital expenditures on structures (*PLANT*); materials and energy costs (*MATCOST*); energy costs (*ENERGY*) and labor costs (*PAY*).[55] We obtain industry-level data from the BLS on capital income (*EQKY* and *STKY*), productive capital stock (*EQPK* and *STPK*), and capital composition (*EQKC* and *STKC*). These can be used to back out rental prices for equipment and structures.

Total cost for industry i in year t is calculated as shown in (B6).

$$TC_{it} = (EQRKL_{it} * EQUIP_{it}) + (STRKL_{it} * PLANT_{it}) + PAY_{it} + MATCOST_{it} \tag{B6}$$

where *EQRKL* and *STRKL* are rental prices we calculate as shown in (B7).[56]

$$EQRKL_{it} = \frac{EQKY_{it}}{EQPK_{it} * EQKC_{it}} \qquad STRKL_{it} = \frac{STKY_{it}}{STPK_{it} * STKC_{it}} \tag{B7}$$

Since industry cost shares can be noisy and using current year cost shares presumes that factor adjustment costs are entirely absent, we use the time averaged cost share between t and t-1 in our TFP calculation (see Syverson (2011) for more discussion). The first year of an industry coding change (1987 and 1997) and the first year of our data (1972) are exceptions. For these

[55] The NBER-CES Manufacturing Industry Database is currently available only through 2009. We imputed 2010 values using related variables in the 2010 ASM microdata and data available from the BEA and the BLS.
[56] The BLS releases rental prices for equipment and structures capital as indices. Our rental prices converted to indices match the BLS rental prices exactly.

years, we use the cost share in year *t*. We also considered cost shares that are the time averages over all periods (separately for the NAICS and SIC years). We find TFP so calculated has a correlation very close to 1 (0.995) with the TFP we use in our analysis.

B.6. Calculation of TFP

We calculate establishment-level log TFP as shown in (B8). We calculate TFP only for establishments with positive values for each of the establishment-level inputs and output.

$$LTFP_{et} = \log(Q_{et}) - IAKE_{it} * \log(KSTEQ_{et}) - IAKS_{it} * \log(KSTST_{et})$$

$$-IAL_{it} * \log(TH_{et}) - IAM_{it} * \log(M_{et}) - IAE_{it} * \log(E_{et}) \qquad \text{(B8)}$$

For the final sample used in the analysis, note we exclude observations that appear to have been imputed using the industry average ratios of shipments and materials to payroll. Our exclusion criteria use the methods developed and used by Dunne (1998) and Roberts and Supina (1996). The industry average ratio of imputing is arguably the most problematic item imputation approach used by the Census Bureau in terms of distorting the relationships in the micro data. We exclude about 7,000 establishments using this method. We detect more Dunne/Roberts/Supina cases in Census years as would be expected since there are many more small establishments surveyed in a Census year as compared to an ASM year. It also appears that item imputation rates rose in the post-2000 period since we detect more Dunne/Roberts/Supina cases over that period. Like Baily, Hulten and Campbell (1992) we delete observations that deviate from the industry/year mean of TFP by more than 200 log points in absolute value. This trims less than 1 percent of the upper and lower tails of the within industry-year TFP distribution.

C. Creation of Propensity Score Weights

Although the primary dependent variable for this analysis, TFP, is only available for observations in the ASM/CM, the LBD contains accurate establishment-level data on employment, size, payroll, industry classification, job creation and job destruction for the entire universe of U.S. manufacturing establishments. Thus, we match ASM/CM establishments to the LBD and use LBD measures of the above variables in our regression analyses. We refer to the integrated data as the ASM/CM/LBD sample. Furthermore, to ensure the ASM/CM/LBD sample is representative of the entire universe of manufacturing establishments, we calculate propensity scores to generate an appropriate set of population weights.

We match establishments in the ASM/CM to LBD establishments by year and "LBD Number." LBD Number is an establishment identifier that exists on both datasets.[57] For each establishment in the LBD for each year from 1981 to 2010, we create a dummy variable that is equal to one if the establishment is in both the ASM/CM and the LBD for that year and equal to zero if the establishment is only in the LBD ("ASM/CM Dummy"). The ASM/CM Dummy for each year then serves as the dependent variable in the regressions that create the propensity scores. Note in CM years, establishments that are administrative records cases have all imputed data, and we set the ASM/CM dummy=0 for such cases.

The propensity scores are created from a logistic regression where the ASM/CM Dummy is the dependent variable and a series of dummy variables that capture establishment characteristics are the independent variables. The variables in the logistic regression analysis are: a dummy for whether an establishment is part of a multi-unit entity, establishment size class (measured by employment), payroll and detailed industry codes. These variables are obvious candidates for this analysis since the probability of selection into the ASM sample and the selection of administrative records cases in the CM vary explicitly by industry and size. We also note ASM sampling and administrative records case thresholds vary across years so it is critical to estimate the propensity score models separately by year. This is especially important given our approach of combining CM and ASM years in a common sample.

From the LBD, we have 4-digit SIC codes through 1996 and 6-digit NAICS codes for 1997 forward. Using dummy variables corresponding directly to 4-digit SIC codes and 6-digit

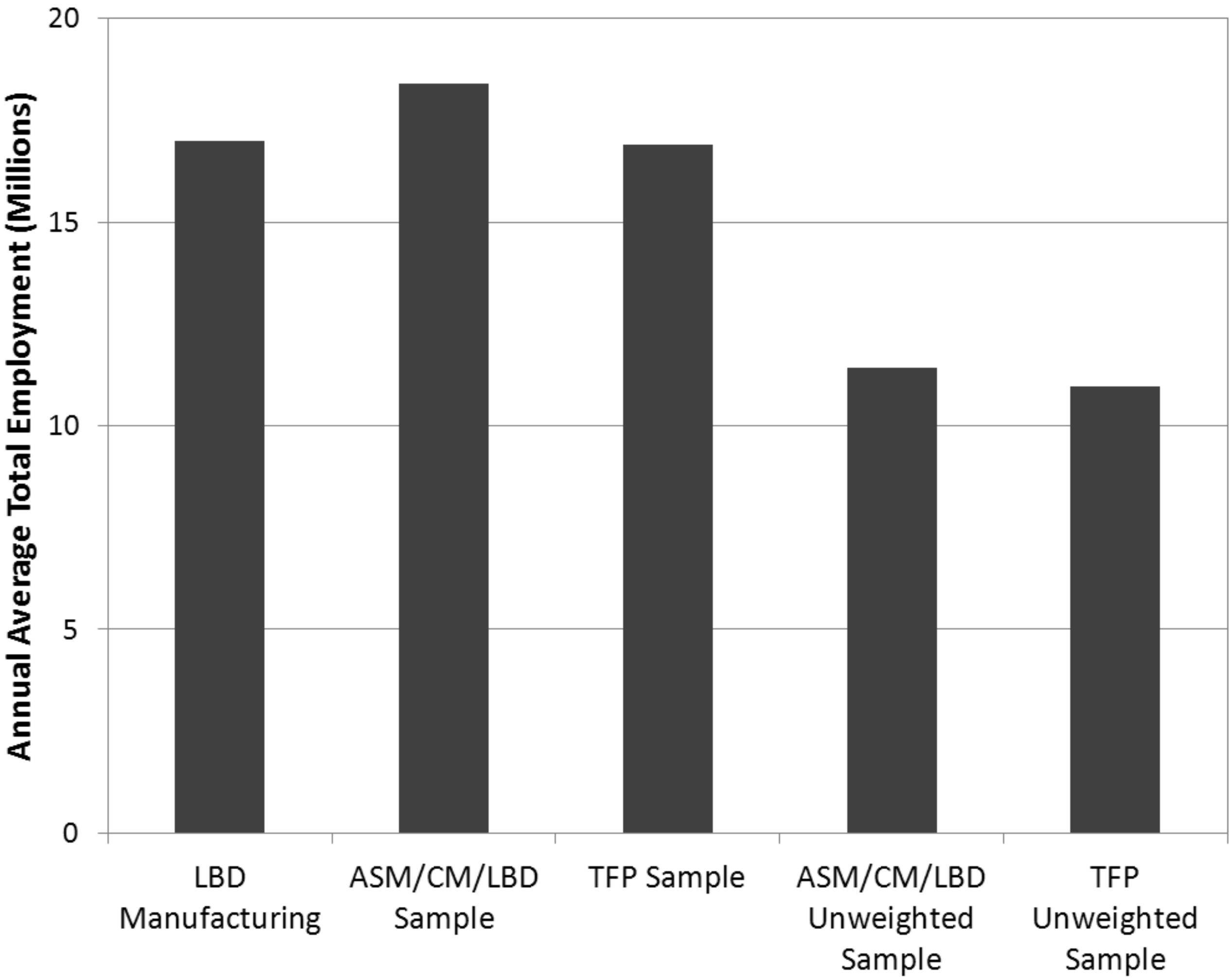
[57] While linking the datasets by LBD Number is straightforward, there are a small percentage of establishment-year observations that do not match due to timing issues between the ASM/CM and the LBD.

NAICS codes leads to convergence issues for our logistic regression in some years because a small number of detailed industries have a relatively small number of observations in specific years. Although we could easily achieve convergence of our logistic model by using broad industry categories corresponding to 2-digit SIC codes and 3-digit NAICS codes, we use a hybrid method, described below, to preserve as much variation as possible at the detailed industry level.

We create modified detailed industry classifications for this analysis by implementing the following procedure. First, we count the number of establishments per 4-digit SIC (6-digit NAICS). Second, we identify the 4-digit SIC (6-digit NAICS) with the maximum number of observations in its 3-digit SIC (4-digit NAICS) universe. Next, we match every 4-digit SIC (6-digit NAICS) to the 4-digit SIC (6-digit NAICS) with the maximum number of establishment observations within the relevant 3-digit SIC (4-digit NAICS) family. If a 4-digit SIC (6-digit NAICS) is associated with 20 or fewer establishments in the full dataset, then its detailed industry is recoded with the 4-digit SIC (6-digit NAICS) corresponding to the maximum within the 3-digit SIC (4-digit NAICS) family.

To confirm our propensity score matching approach is reasonable we compare manufacturing employment in the LBD to the weighted employment calculated for the ASM/CM/LBD sample and the weighted employment for those establishments in the ASM/CM reporting values for TFP. Figure C.1 shows we match annual average total employment quite well with the weighted samples – and obviously are substantially short in the unweighted samples. The critical aspect of the weighting is to make the weighted sample match the size and age distributions of the full LBD. Figures C.2 and C.3 show that the weighted samples do exactly this – the unweighted samples have, as expected, higher shares of large and mature establishments. The weighted samples match the full LBD size and age distributions well.

Figure C.1. Annual Average Total Employment in Manufacturing

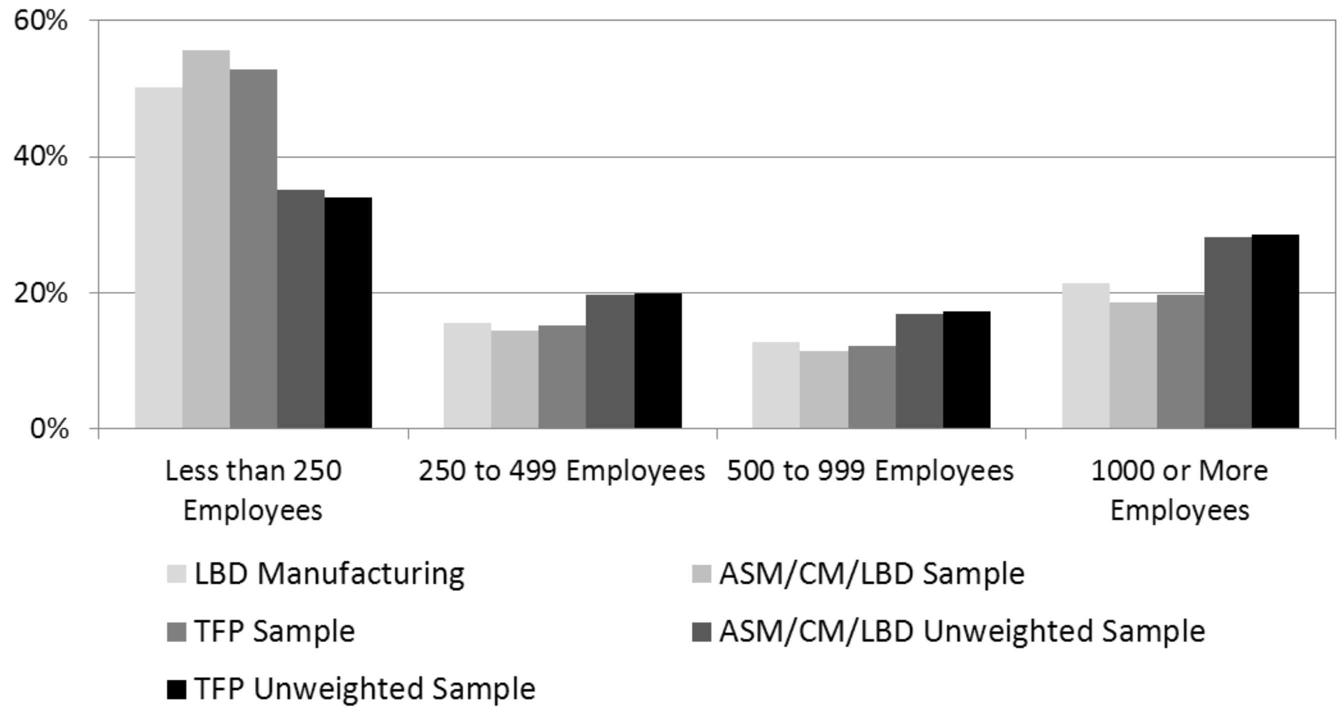


Source: Authors' calculations on the ASM, CM and LBD.

Notes:

1. LBD Manufacturing includes all manufacturing establishments in the LBD from 1981-2010.
2. ASM/CM/LBD Sample is all ASM/CM establishments that match to the LBD from 1981-2010. Statistics weighted by our created propensity score weight.
3. TFP Sample is all ASM/CM establishments that match to the LBD for which we can calculate TFP from 1981-2010. Statistics weighted by our created propensity score weight.
4. ASM/CM/LBD Unweighted Sample is the ASM/CM Sample where statistics are unweighted.
5. TFP Unweighted Sample is the TFP Sample where statistics are unweighted.

Figure C.2. Percent of Observations by Establishment Size Class

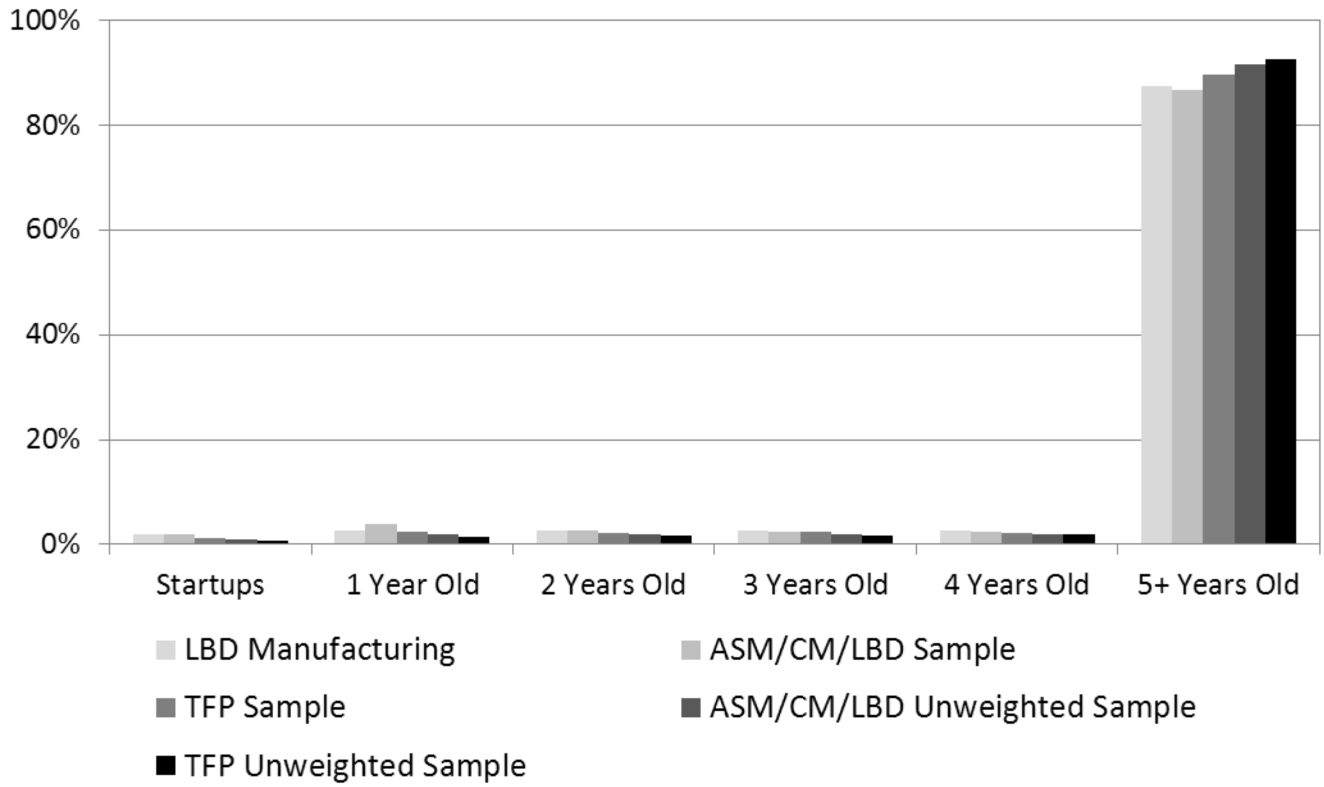


Source: Authors' calculations on the ASM, CM and LBD.

Notes:

1. LBD Manufacturing includes all manufacturing establishments in the LBD from 1981-2010.
2. ASM/CM/LBD Sample is all ASM/CM establishments that match to the LBD from 1981-2010. Statistics weighted by our created propensity score weight.
3. TFP Sample is all ASM/CM establishments that match to the LBD for which we can calculate TFP from 1981-2010. Statistics weighted by our created propensity score weight.
4. ASM/CM/LBD Unweighted Sample is the ASM/CM Sample where statistics are unweighted.
5. TFP Unweighted Sample is the TFP Sample where statistics are unweighted.

Figure C.3. Percent of Observations by Establishment Age



Source: Authors' calculations on the ASM, CM and LBD.

Notes:

1. LBD Manufacturing includes all manufacturing establishments in the LBD from 1981-2010.
2. ASM/CM/LBD Sample is all ASM/CM establishments that match to the LBD from 1981-2010. Statistics weighted by our created propensity score weight.
3. TFP Sample is all ASM/CM establishments that match to the LBD for which we can calculate TFP from 1981-2010. Statistics weighted by our created propensity score weight.
4. ASM/CM/LBD Unweighted Sample is the ASM/CM Sample where statistics are unweighted.
5. TFP Unweighted Sample is the TFP Sample where statistics are unweighted.

D. Measuring Job Creation and Destruction

Following, Davis, Haltiwanger, and Schuh (1996), the job creation (*JC*) and job destruction (*JD*) rates for establishment *e* in group *q* in time *t* are defined in the following manner:[58]

$$JC_{qt} = \sum_{e \in Q+} (X_{eqt} / X_{qt})\ g_{eqt} \tag{D.1}$$

$$JD_{qt} = \sum_{e \in Q-} (X_{eqt} / X_{qt})\ \left|g_{eqt}\right| \tag{D.2}$$

where:

$$X_{eqt} = .5(E_{eqt} + E_{eq,t-1}) \tag{D.3}$$

$$g_{eqt} = \Delta E_{eqt} / X_{eqt} \tag{D.4}$$

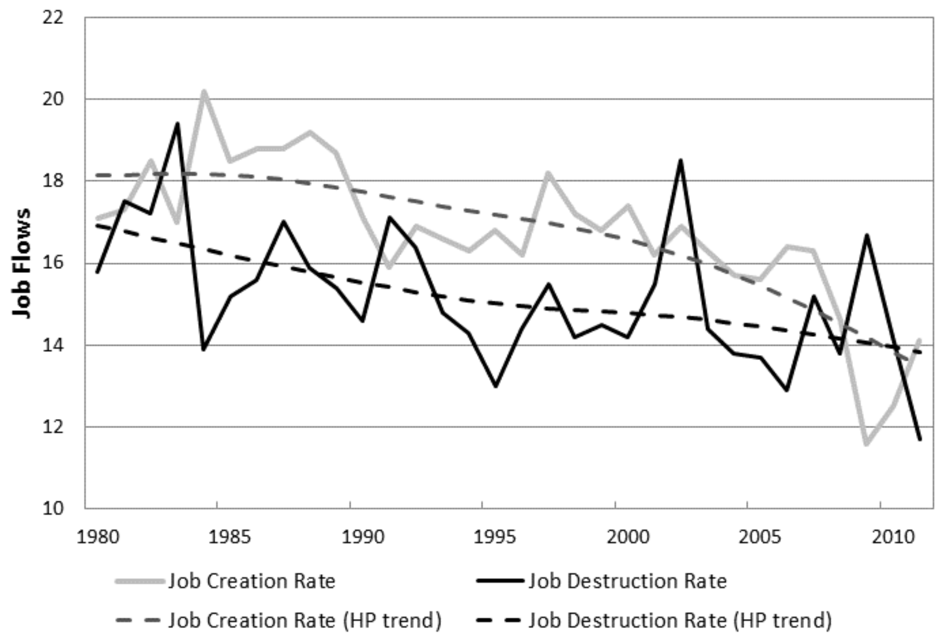
Total job reallocation (*REALL*) is the sum of the job creation and job destruction rates (*REALL*=*JC*+*JD*) and the net employment growth rate (*NET*) is the job creation rate less the job destruction rate (*NET*= *JC*-*JD*).

[58] $Q+$ captures expanding establishments including startups and $Q-$ contracting establishments including shutdowns.

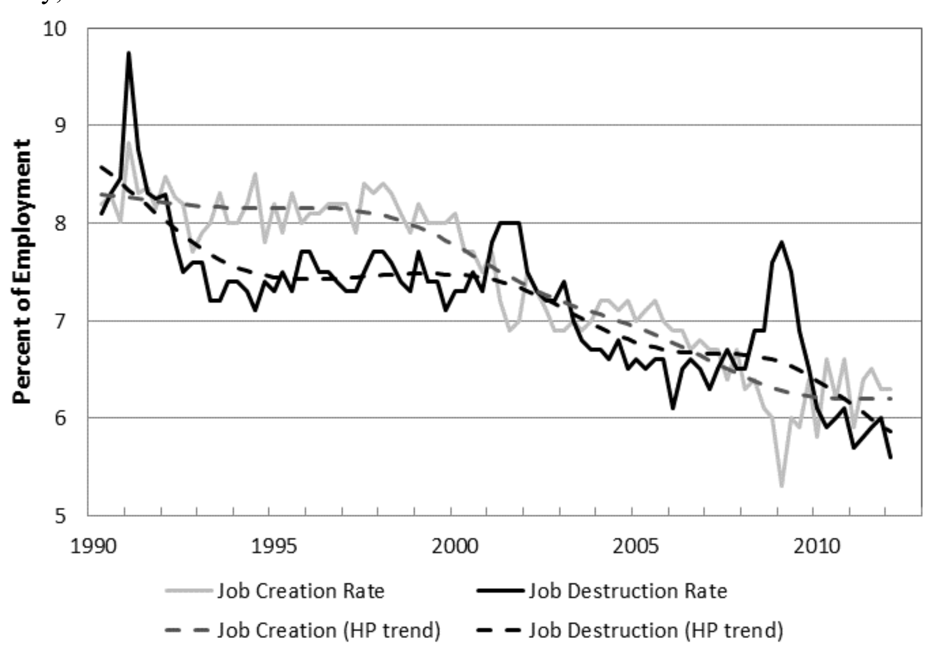
E. Sensitivity Analysis Figures and Tables

Figure E.1. Job Flows and the Business Cycle -- Trends

A. Annual, 1980-2011



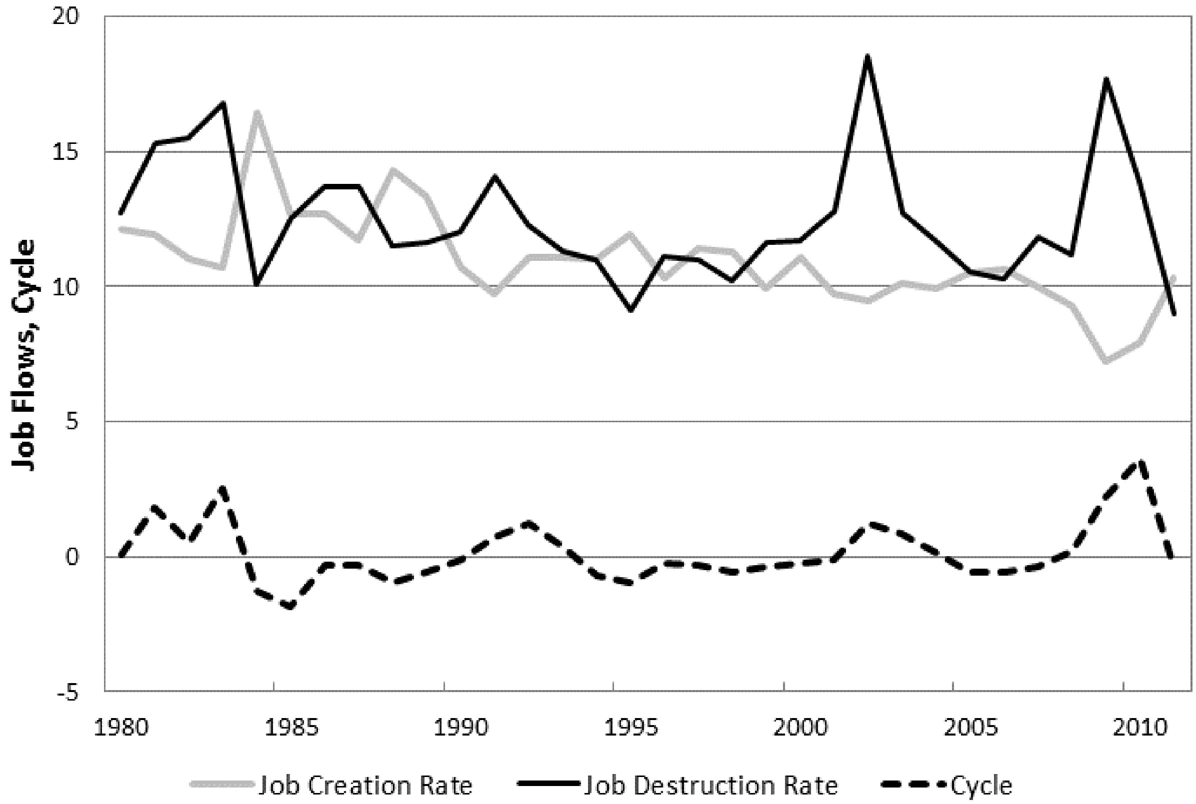
B. Quarterly, 1990:2-2012:1



Source: Authors calculations using the BDS (Annual), BED (Quarterly) and CPS.

Note: Cycle is the change in the unemployment rate.

Figure E.2. Job Flows and the Business Cycle, *Manufacturing Sector*, 1980-2011

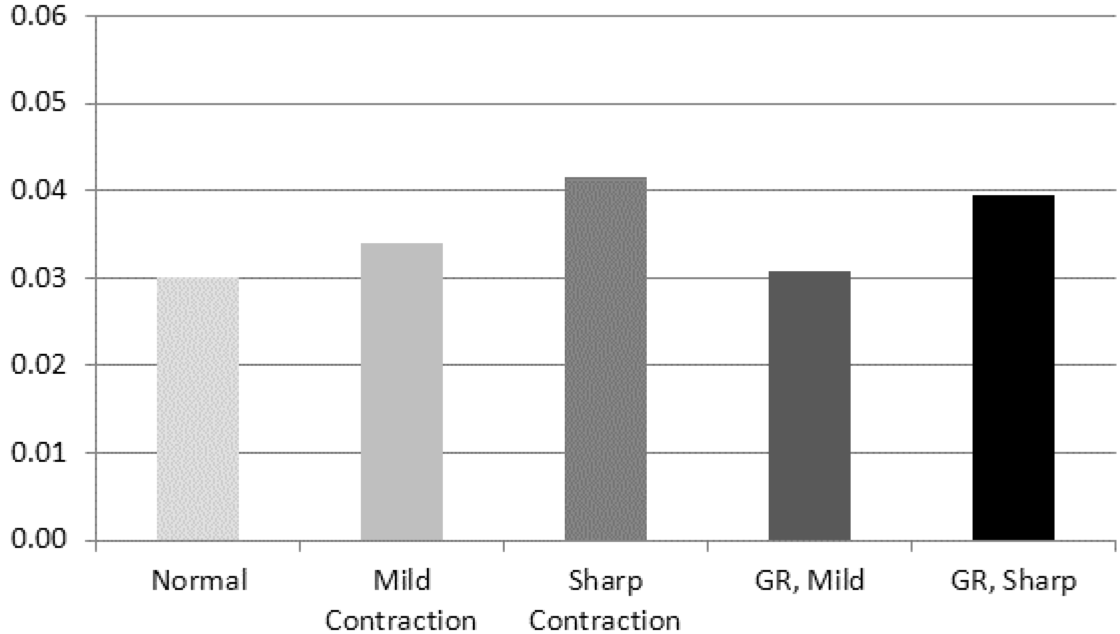


Source: Authors' calculations on the BDS.

Notes:

1. Cycle is the year change in the national unemployment rate. This is timed appropriately with the BDS.
2. Job flows for year *t* reflect the changes from March in year *t*-1 to March in year *t*.

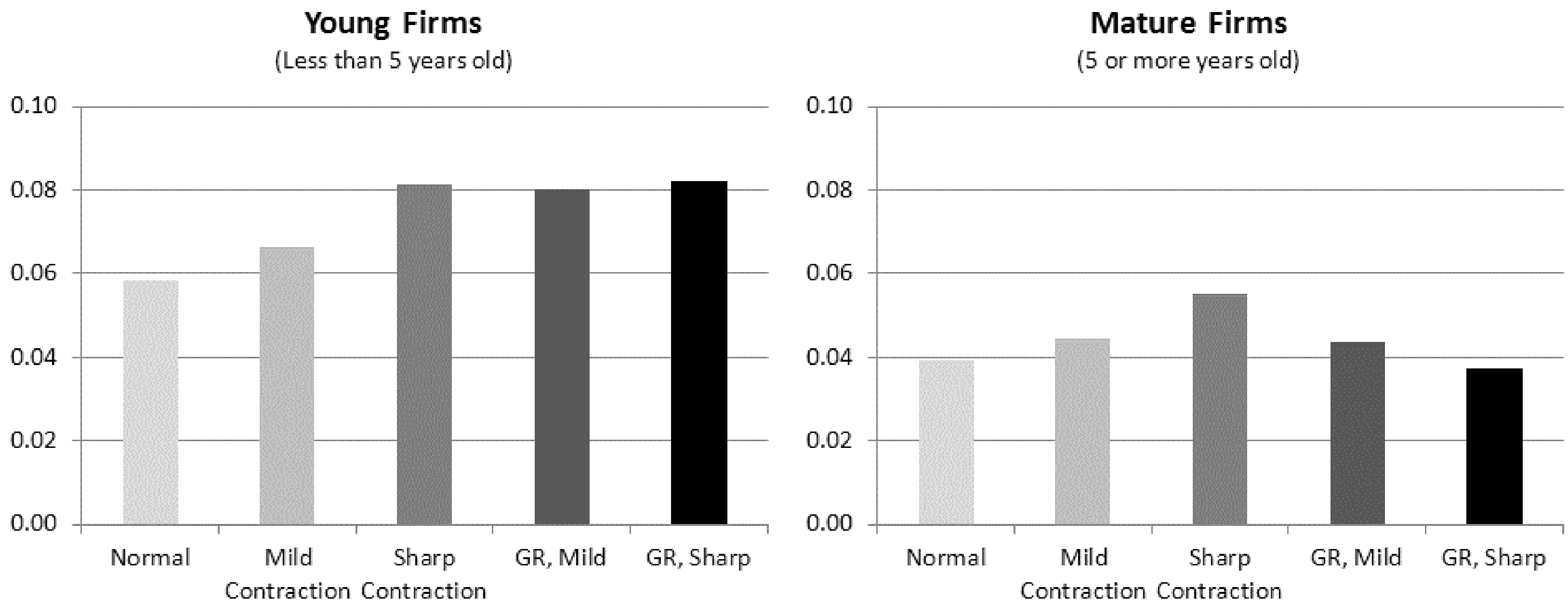
Figure E.3. Differences in Conditional Growth Rates (Continuing Establishments) Between High and Low Productivity Establishments Over the Business Cycle



Source: Authors' calculations on the ASM, CM and LBD.

Notes: Depicted is the predicted difference in growth rates between an establishment one standard deviation above industry-by-year mean productivity and an establishment one standard deviation below industry-by-year mean productivity. Normal is zero change in state-level unemployment, mild contraction is 1 percentage point increase in state level unemployment, sharp contraction is 3 percentage point increase in state-level unemployment, GR is for period 2007-09.

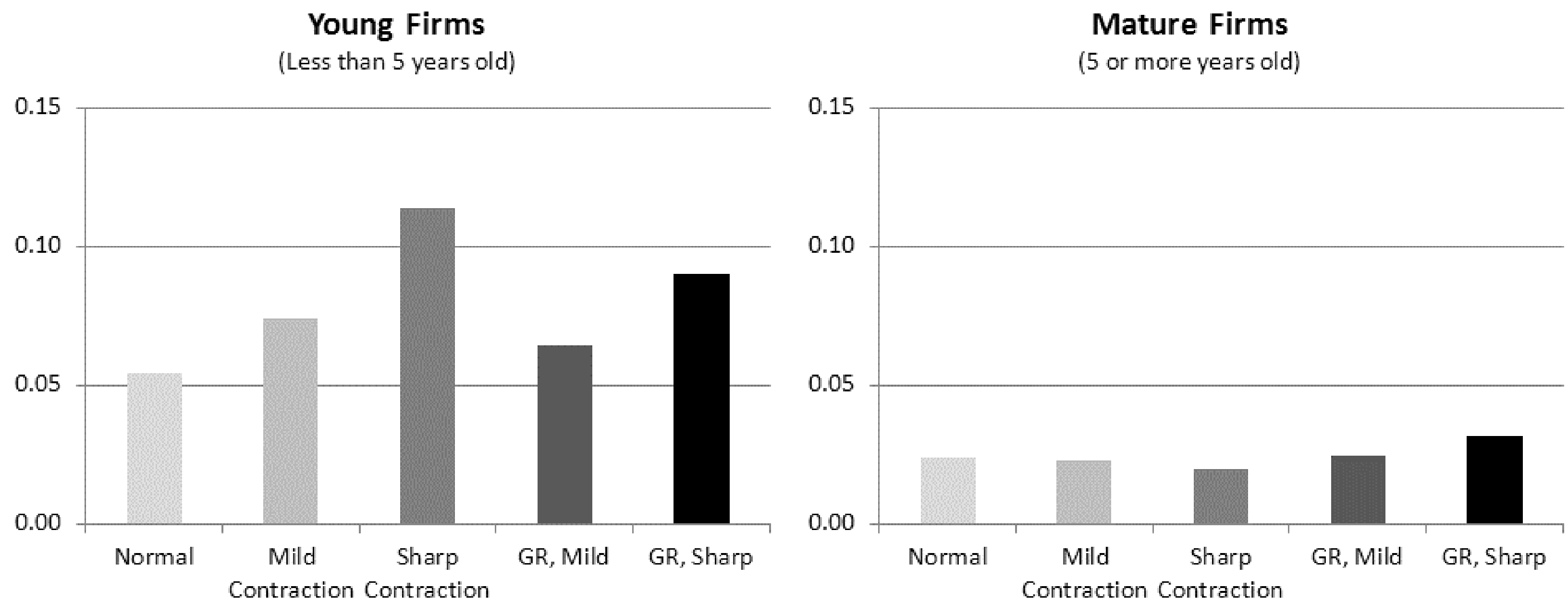
Figure E.4. Difference in Exit Rates Between Low and High Productivity Establishments Over the Business Cycle: By Firm Age



Source: Authors' calculations on the ASM, CM and LBD.

Notes: Depicted is the predicted difference in probability of exit (low minus high) between an establishment one standard deviation above industry-by-year mean productivity and an establishment one standard deviation below industry-by-year mean productivity. Normal is zero change in state-level unemployment, mild contraction is 1 percentage point increase in state level unemployment, sharp contraction is 3 percentage point increase in state-level unemployment, GR is for period 2007-09.

Figure E.5. Differences in Conditional Growth Rates (Continuing Establishments) Between High and Low Productivity Establishments Over the Business Cycle: By Firm Age



Source: Authors' calculations on the ASM, CM and LBD.

Notes: Depicted is the predicted difference in growth rates (high minus low) between an establishment one standard deviation above industry-by-year mean productivity and an establishment one standard deviation below industry-by-year mean productivity. Normal is zero change in state-level unemployment, mild contraction is 1 percentage point increase in state level unemployment, sharp contraction is 3 percentage point increase in state-level unemployment, GR is for period 2007-09.

Table E.1. Job Flows and Change in the *State-Level* Unemployment Rate (Annual) using both Great Recession and 1981-83 Recession Interactions

	Job Creation Rate	**Job Destruction Rate**	**Reallocation Rate**
Cycle	-0.551***	1.204***	0.652***
	(0.062)	(0.059)	(0.077)
80sR*Cycle	-0.234	-0.026	-0.261
	(0.124)	(0.144)	(0.219)
GR*Cycle	-0.440***	-0.429***	-0.869***
	(0.073)	(0.083)	(0.109)
Trend	-0.173***	-0.137***	-0.309***
	(0.011)	(0.011)	(0.021)
N	1,581	1,581	1,581

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations on the BDS.

Notes:

1. 80sR is a dummy variable equal to one for years from 1981 to 1983 (job flows from March 1980 to March 1983). GR is a dummy variable equal to one for years from 2008 to 2010 (job flows from March 2007 to March 2010).
2. Cycle is the *state*-year change in the unemployment rate.
3. Standard errors (in parentheses) clustered at the state level.

Table E.2. Job Flows and Change in the *State-Level* Unemployment Rate (Annual), *Age of Establishment*

	Job Creation Rates		Job Destruction Rates	
	Young	**Mature**	**Young**	**Mature**
Cycle	-1.402^{***}	-0.266^{***}	1.253^{***}	0.669^{***}
	(0.128)	(0.033)	(0.079)	(0.046)
GR*Cycle	-0.609^{***}	-0.015	0.162	-0.083
	(0.170)	(0.052)	(0.118)	(0.062)
Trend	-0.083^{***}	-0.094^{***}	-0.077^{***}	-0.115^{***}
	(0.011)	(0.006)	(0.012)	(0.009)
N	1,581	1,581	1,581	1,581

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations on the BDS.

Notes:

1. GR is a dummy variable equal to one for years from 2008 to 2010 (job flows from March 2007 to March 2010).
2. Cycle is the *state*-year change in the unemployment rate.
3. All specifications include state fixed effects.
4. Standard errors (in parentheses) clustered at the state level.

Table E.3. Reallocation and Productivity Over the Business Cycle, *No Year Effects*

	Overall Growth Rate (Continuers + Exiters)		Exit		Conditional Growth Rate (Continuers Only)	
	(1)	(2)	(3)	(4)	(5)	(6)
GR		-0.097***		0.027***		-0.044***
		(0.011)		(0.005)		(0.006)
TFP	0.157***	0.158***	-0.060***	-0.060***	0.041***	0.042***
	(0.006)	(0.006)	(0.003)	(0.003)	(0.003)	(0.003)
Cycle	-4.333***	-3.652***	0.876***	0.644***	-2.813***	-2.564***
	(0.330)	(0.376)	(0.137)	(0.147)	(0.141)	(0.174)
TFP*Cycle	1.550**	2.216**	-0.658***	-0.924***	0.500	0.595
	(0.667)	(0.879)	(0.229)	(0.269)	(0.428)	(0.578)
GR*TFP		0.029		-0.017*		-0.004
		(0.022)		(0.011)		(0.010)
GR*Cycle		1.047**		-0.145		0.719**
		(0.467)		(0.235)		(0.332)
GR*TFP*Cycle		-3.148*		1.464**		-0.157
		(1.620)		(0.688)		(0.749)
Year FE	no	no	no	no	no	no
State FE	yes	yes	yes	yes	yes	yes
Firm Size Class FE	yes	yes	yes	yes	yes	yes
N (millions)	2.2	2.2	2.2	2.2	2.1	2.1

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations on the ASM, CM and LBD.

Notes:

1. Regressions weighted by propensity score weights. Weight calculation described in Appendix C.
2. Standard errors (in parentheses) clustered at the state level.
3. Employment growth and exit are measured from period *t* to period *t*+1. Regression for exit is a linear probability model where exit=1 if the establishment has positive activity in period *t* but no activity in period *t+1*.
4. TFP is the deviation of establishment-level log TFP from its' industry-year mean in year *t*.
5. GR is a dummy variable equal to one for years from 2007 to 2009.
6. Cycle is the state-year change in the unemployment rate from *t* to *t*+1.
7. Log establishment employment included as a control.

Table E.4. Reallocation and Productivity over the Business Cycle, *No State Effects*

	Overall Growth Rate (Continuers + Exiters)		**Exit**		**Conditional Growth Rate (Continuers Only)**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
TFP	0.155***	0.157***	-0.059***	-0.060***	0.041***	0.041***
	(0.006)	(0.006)	(0.002)	(0.002)	(0.003)	(0.003)
Cycle	-3.797***	-3.272***	0.891***	0.622***	-2.195***	-2.189***
	(0.561)	(0.542)	(0.233)	(0.203)	(0.247)	(0.289)
TFP*Cycle	1.552**	2.184**	-0.658***	-0.926***	0.500	0.541
	(0.646)	(0.869)	(0.227)	(0.267)	(0.413)	(0.568)
GR*TFP		0.031		-0.019*		-0.005
		(0.022)		(0.011)		(0.011)
GR*Cycle		-4.639***		2.383***		-0.044
		(1.735)		(0.656)		(0.787)
GR*TFP*Cycle		-2.985*		1.472**		0.060
		(1.625)		(0.685)		(0.768)
Year FE	yes	yes	yes	yes	yes	yes
State FE	no	no	no	no	no	no
Firm Size Class FE	yes	yes	yes	yes	yes	yes
N (millions)	2.2	2.2	2.2	2.2	2.1	2.1

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations on the ASM, CM and LBD.

Notes:
1. Regressions weighted by propensity score weights. Weight calculation described in Appendix C.
2. Standard errors (in parentheses) clustered at the state level.
3. Employment growth and exit are measured from period *t* to period *t*+1. Regression for exit is a linear probability model where exit=1 if the establishment has positive activity in period *t* but no activity in period *t+1*.
4. TFP is the deviation of establishment-level log TFP from its' industry-year mean in year *t*.
5. GR is a dummy variable equal to one for years from 2007 to 2009 (reflecting outcomes from March 2007 to March 2010).
6. Cycle is the state-year change in the unemployment rate from *t* to *t*+1.
7. Log establishment employment included as a control.

Table E.5. Reallocation and Productivity over the Business Cycle,
Cycle is Change in Employment-to-Population Ratio

	Overall Growth Rate (Continuers + Exiters)		Exit		Conditional Growth Rate (Continuers Only)	
	(1)	(2)	(3)	(4)	(5)	(6)
TFP	0.158***	0.159***	-0.060***	-0.061***	0.042***	0.041***
	(0.006)	(0.006)	(0.003)	(0.003)	(0.003)	(0.003)
Cycle	2.624***	2.451***	-0.666***	-0.561***	1.393***	1.424***
	(0.438)	(0.457)	(0.151)	(0.162)	(0.223)	(0.264)
TFP*Cycle	-1.357**	-1.936**	0.660**	0.963***	-0.270	-0.162
	(0.692)	(0.774)	(0.300)	(0.278)	(0.386)	(0.516)
GR*TFP		0.032		-0.020*		-0.007
		(0.023)		(0.011)		(0.011)
GR*Cycle		1.422		-0.878**		-0.267
		(0.882)		(0.378)		(0.753)
GR*TFP*Cycle		3.229*		-1.849**		-0.650
		(1.893)		(0.908)		(0.810)
Year FE	yes	yes	yes	yes	yes	yes
State FE	yes	yes	yes	yes	yes	yes
Firm Size Class FE	yes	yes	yes	yes	yes	yes
N (millions)	2.2	2.2	2.2	2.2	2.1	2.1

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations on the ASM, CM and LBD.

Notes:
1. Regressions weighted by propensity score weights. Weight calculation described in Appendix C.
2. Standard errors (in parentheses) clustered at the state level.
3. Employment growth and exit are measured from period *t* to period *t*+1. Regression for exit is a linear probability model where exit=1 if the establishment has positive activity in period *t* but no activity in period *t+1*.
4. TFP is the deviation of establishment-level log TFP from its' industry-year mean in year *t*.
5. GR is a dummy variable equal to one for years from 2007 to 2009 (reflecting outcomes from March 2007 to March 2010).
6. Cycle is the state-year change in the employment-to-population ratio from *t* to *t*+1.
7. Log establishment employment included as a control.

Table E.6. Reallocation and Productivity over the Business Cycle, *Excluding 1981-83*

	Overall Growth Rate (Continuers + Exiters)		Exit		Conditional Growth Rate (Continuers Only)	
	(1)	(2)	(3)	(4)	(5)	(6)
TFP	0.156^{***}	0.157^{***}	-0.060^{***}	-0.061^{***}	0.039^{***}	0.039^{***}
	(0.007)	(0.007)	(0.003)	(0.003)	(0.003)	(0.003)
Cycle	-3.350^{***}	-2.918^{***}	0.695^{***}	0.465^{**}	-2.153^{***}	-2.158^{***}
	(0.505)	(0.537)	(0.205)	(0.200)	(0.249)	(0.304)
TFP*Cycle	0.988^{*}	1.474^{**}	-0.470^{**}	-0.751^{**}	0.281	0.092
	(0.551)	(0.717)	(0.230)	(0.291)	(0.346)	(0.524)
GR*TFP		0.031		-0.018		-0.002
		(0.023)		(0.011)		(0.011)
GR*Cycle		-2.997^{**}		1.597^{***}		0.031
		(1.437)		(0.528)		(0.811)
GR*TFP*Cycle		-2.245		1.288^{*}		0.516
		(1.556)		(0.715)		(0.746)
Year FE	yes	yes	yes	yes	yes	yes
State FE	yes	yes	yes	yes	yes	yes
Firm Size Class FE	yes	yes	yes	yes	yes	yes
N (millions)	1.9	1.9	1.9	1.9	1.8	1.8

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations on the ASM, CM and LBD.

Notes:
1. Regressions weighted by propensity score weights. Weight calculation described in Appendix C.
2. Standard errors (in parentheses) clustered at the state level.
3. Employment growth and exit are measured from period t to period t+1. Regression for exit is a linear probability model where exit=1 if the establishment has positive activity in period t but no activity in period $t+1$.
4. TFP is the deviation of establishment-level log TFP from its' industry-year mean in year t.
5. GR is a dummy variable equal to one for years from 2007 to 2009 (reflecting outcomes from March 2007 to March 2010).
6. Cycle is the state-year change in the unemployment rate from t to t+1.
7. Log establishment employment included as a control.

Table E.7. Reallocation and Productivity over the Business Cycle,
Accounting for Capacity Utilization by including Controls for Capital-Energy Ratio

	Overall Growth Rate (Continuers + Exiters)		**Exit**		**Conditional Growth Rate (Continuers Only)**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
TFP	0.148***	0.151***	-0.055***	-0.055***	0.043***	0.044***
	(0.006)	(0.006)	(0.003)	(0.003)	(0.003)	(0.003)
Cycle	-3.262***	-2.960***	0.638***	0.482***	-2.158***	-2.148***
	(0.455)	(0.484)	(0.176)	(0.181)	(0.249)	(0.291)
TFP*Cycle	1.610**	2.381***	-0.679***	-1.007***	0.500	0.538
	(0.626)	(0.834)	(0.215)	(0.244)	(0.421)	(0.584)
GR*TFP		0.030		-0.019*		-0.007
		(0.021)		(0.010)		(0.010)
GR*Cycle		-2.555*		1.350***		-0.034
		(1.337)		(0.509)		(0.748)
GR*TFP*Cycle		-3.751***		1.794***		-0.106
		(1.453)		(0.605)		(0.785)
Year FE	yes	yes	yes	yes	yes	yes
State FE	yes	yes	yes	yes	yes	yes
Firm Size Class FE	yes	yes	yes	yes	yes	yes
N (millions)	2.2	2.2	2.2	2.2	2.1	2.1

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors' calculations on the ASM, CM and LBD.

Notes:

1. Regressions weighted by propensity score weights. Weight calculation described in Appendix C.
2. Standard errors (in parentheses) clustered at the state level.
3. Employment growth and exit are measured from period *t* to period *t*+1. Regression for exit is a linear probability model where exit=1 if the establishment has positive activity in period *t* but no activity in period *t+1*.
4. TFP is the deviation of establishment-level log TFP from its' industry-year mean in year *t*.
5. These specifications include as additional controls E/K is the deviation of establishment-level log energy-capital ratio from its' industry-year mean in year *t*. E/K is entered in by itself, interacted with the cycle variable, with the GR recession dummy and a 3-way interaction with the cycle variable and the Great Recession dummy.
6. GR is a dummy variable equal to one for years from 2007 to 2009 (reflecting outcomes from March 2007 to March 2010).
7. Cycle is the state-year change in the unemployment rate from *t* to *t*+1.
8. Log establishment employment included as a control.

Appendix References

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