Heterogeneous Effects of Factor Intensity on Creative Destruction

Bailey Johnson November 8th, 2024

Abstract

This paper aims to better fit firm entry and exit dynamics following recessions and it's associated effects on productivity. Using public American firm data of Compustat I show productivity regressions following a recession by sector to show sector specific effects. In doing this we do see some sector differences which, beyond features described in the existing literature, may be partially driven by their different uses of factors of production. Using data on job flows and factor usage as a goal, I put together a modified firm dynamics on creative destruction model which includes greater diversity on capital usage as well as the option of firms to take out longer term debt. Through this model with longer debt contracts I can extend out mean reversion after a recession or depth of the initial shocks to better match a given recession. Productivity transitions helped guide the lending behavior costs in ways that sometimes shut out productive firms from getting their desired debt contracts. I show some of the expected behavior differences between capital and labor intensive firms and some examples of calibrating these firms presence to better look like the sectors one sees in a given economy.

Economic growth is often described by highlighting technological achievements and the efficient allocation of resources with what we're given but to reach this we depend on the natural selection among these approaches to meet human needs. Economic growth can come from many sources such as technological improvements, a growing labor force, capital accumulation, better human capital, or efficient allocation of resources. In some analysis describing the effects of factor reallocation such as in Foster Haltiwanger Krizan 2001 it is estimated to make up over half of the productivity growth. Creative destruction suggests it is necessary to reallocate resources from unproductive incumbent firms to newer innovative firms who better serve market needs. This has two parts, the firm destruction and the firm creation. Ideally, inefficient existing firms should leave and high productivity new firms should enter. Sometimes inefficient firms can become more efficient, but sometimes it is not possible without large investments or significant changes in the firm organization which may be unlikely and difficult. During a recession these firms are at a greater risk of failing. If the firms exiting were truly the most inefficient and not merely the most constrained by market distortions then it should drive up average productivity and the resources will be freed up to better uses. Not enough stimulus does risk allowing too many firms to fail, some of which may be critical. The early attempts at modeling this were using microeconomic firm decisions that were describing single sources. Later this shifted to firm dynamic models with further variations on financing or labor decisions. There is a still a need for sorting out the

UCLA, Department of Economics. Email: johnsonbailey64@gmail.com ; Website: www.bailey-johnson.com

relative importance of the impact of these potential influences on creative destruction. If there is a greater understanding of these drivers then you can better regulate competition and better manage the business cycle. Albeit at a temporary economic cost, some inefficient large firms must fail to improve reallocation. And it must be easy for new productive firms to enter the market. Contagion effects do complicate this since it may not be efficient to end productive firms who fail due to their connection with an unproductive one. To develop an improved model I consider methods and results of a series of popular models and explanations of creative destruction. First I look into two of the earlier creative destruction models by Caballero and Hammour. The first one suggests there is exogenously improving technology that firms can implement by entering and then through exogenous means or demand shocks they reach zero profit and exit. The second one improves upon this by introducing more heterogeneity in firm productivity and a more complex interaction between workers, entrepreneurs and financiers. The result allows for varied results from recessions under debt frictions. That recession could have negative results on productivity if the exits were due to productive firms who can't borrow. I find the job flows data of the former paper and the marginal revenue product data of Gamberoni Giordano Lopez-Garcia based on the Hsieh Klenow 2009 productivity measure useful as a goal to match a model results to. I note another empirical paper by Foster Grim Haltiwanger which points out that not every recession is having similar effects on productivity. They had different impacts in EU and America, some recessions impacted destruction or creation differently. There is then a more modern firm dynamics model by Osotimehin and Pappada that makes the firm decision problem and productivity transitions more complex in an effort to fit in more varied sources of shocks to explain the varied responses to factor reallocation. This model allows for modifications that can show key features of the recession responses and could be calibrated for any economy with the relevant firm flows data. Noting some of the differences among capital and labor decisions in recessions I ran a series of regressions to see efficiency changes following recessions in various American industries in public firms using compustat data. This regression was based on the Foster Grim Haltiwanger 2011 specification and it led me to believe I should do more with factor intensity heterogeneity. Then I suggest and implement a potential model which can address other sources of firm heterogeneity. I allow for interest rates to change to represent monetary policy changes. For the purpose of allowing spiked behavior following recession and drawn out effects, I allow firms to exploit these differences with fixed rate debt contracts. I then introduce a labor hold-up feature to the model to then offer more differences between capital and labor intensive firms.

The layout of my paper is that in the following section I will examine one of these papers at a time to better see what is found and lacking. In the section following that I use a series of regressions motivated by these papers to learn more about the features of heterogeneity in productivity following recessions using sectoral differences. Then in section 3 using those facts and the existing model results I propose and implement my model based on the Osotimehin and Pappada 2016 paper for an improved and flexible firm dynamics model. Section 4 I discuss implications, quality

of results, and conclude.

Section 1 - Literature Review

Creative destruction is the idea that growth and technological progress needs more productive firms and products to displace the less efficient ones so that the less efficient firms resources can be reallocated to something more useful. Creative destruction's popularization started with the works of Joseph Schumpeter, who considered it to be an essential part of capitalism. More modernly, there has been more work attempting to model the factor reallocation that occurs during recessions using firm dynamics models. Ricardo Caballero has written many papers testing the idea of creative destruction. Caballero and Hammour's 1991 paper models the "cleansing effect" of recessions on firms. They use a partial equilibrium model with competitive firms that face fixed production costs. Firms' production units deteriorate over time and eventually become obsolete, with the obsolescence age determined by simultaneous equations that incorporate unit prices and industry output. Demand changes cyclically, driving the creation and destruction of production units in line with business cycles. The model implies that when creation costs are fixed, only creation rates drop during demand declines. However, if creation costs rise with demand, obsolescence ages fall, accelerating destruction rates in recessions. Caballero uses manufacturing job flow data to approximate these dynamics, noting that creation rates are generally smoother than destruction rates, which aligns with his model's predictions of asymmetric demand.

Caballero and Hammour's 1999 paper, The Cost of Recessions Revisited, extends their previous model by introducing frictions to examine how recessions could worsen productivity cumulatively. Unlike the classic liquidationist view, which expects recessions to boost productivity by eliminating weaker firms, their model allows for scenarios where creation is unchanged or even reduced during downturns. The model incorporates three agents—entrepreneurs, workers, and financiers—alongside constraints in labor and financing. Entrepreneurs need to combine wealth, labor, and external financing to create production units. Firms fail due to financing shortages or if profits turn negative, with destruction rates influenced by wealth dynamics and random output shocks modeled via an Ornstein-Uhlenbeck process. Using a SVAR analysis on job flows data, they find recessions lead to a cumulative decline in creation and increase in destruction. The labor constraint alone leads to smaller welfare losses (1.9% of GDP), whereas combined labor and finance constraints yield a 4.6% GDP loss in a two-standard deviation recession. Financing constraints slow firm creation more sharply, amplifying cumulative reallocation costs. While the model provides insights into recessionary frictions, assumptions like independent firms and fixed timing may limit its realism. Adjustments in firm timing, interest rates, and competition dynamics could offer a more nuanced understanding of recession impacts on productivity.

Gamberoni, Giordano, and Lopez-Garcia's 2016 paper applies the Hsieh-Klenow 2009 model

to analyze factor misallocation in developed European economies, particularly during the Great Recession. They identify three key trends: Capital misallocation worsened over time in four out of five countries (excluding Germany), while labor allocation remained stable. Capital misallocation increased more in the service sector than in industry. Misallocation for both capital and labor fell across countries in 2009, with further declines in some sectors during 2011-2012, suggesting a potential "cleansing effect" from the recession. The authors use various misallocation measures, including the Hsieh-Klenow (2009) measure, Olley-Pakes (1996) indicator, and Petrin-Sivadasan (2013) marginal productivity wedge. These measures align in showing dispersion in marginal revenue productivity for capital and labor, which grew until 2006, dropped during the 2008-2009 recession, and fell again during the 2012 debt crisis. Regression analyses with country and sector fixed effects reveal that changes in credit costs and demand were the largest drivers of MRPK, while turnover and regulation changes most affected MRPL. The cleansing effect was stronger for labor than for capital, indicated by the reduced dispersion in MRPL. Though the study provides insights into misallocation patterns during the recession, it lacks lagged and cumulative effects, and its findings may be specific to Europe. Broader testing with international data and additional controls could enhance the robustness of these results. Or perhaps looking for an event to use differences in differences on in one of these countries. This result also varies from the Oberfield 2011 paper that said in their Chilean recession that capital changes were bigger over the recession than labor. Measures like MRPK and MRPL offer useful empirical tools to study creative destruction, and I will be using their graphics on this data.

Foster, Grim, and Haltiwanger's 2013 paper, Reallocation in the Great Recession: Cleansing or Not, analyzes job reallocation in the U.S. during the Great Recession, contrasting it with previous recessions. Using job flow data from the BLS and Census manufacturing data, they find that earlier recessions brought productivity-enhancing reallocation, while the Great Recession had unusually low job creation and was less productivity-enhancing. They use a propensity score weighting to standardize firm characteristics and measure firm productivity to better match the distribution in their business database. Their job flow analysis shows that job creation was historically low after the Great Recession, while job destruction was high. Regression analysis on productivity using unemployment changes, recession dummies, TFP changes, interactions and fixed effects on states or year, alongside Great Recession-specific dummies and interactions, indicates that exits—especially among young firms—drove much of the productivity decline. The authors then perform an accounting decomposition to simulate productivity effects of varying employment distributions. They find that reallocation contributed less to productivity growth during the Great Recession than in previous downturns. They suggest this may be due to regulatory or credit constraints. The data shows that credit costs influenced productivity post-recession. The study emphasizes that the nature of recessions matters: while earlier recessions promoted reallocation, the Great Recession's constraints on creation and capital access hindered productivity gains typically associated with creative destruction. An emphasis on the financial crisis. I will be

using their regression specifications to influence my regressions to come later.

Osotimehin and Pappada's 2016 paper, Credit Frictions and the Cleansing Effect of Recessions, incorporates credit frictions into a firm dynamics model, suggesting that while recessions can still have a "cleansing effect," these credit frictions weaken it. Firms in the model have varying levels of net worth and both persistent and nonresistant productivity, they produce solely with capital, facing fixed production costs each period. There are higher default thresholds on their firm characteristics if they want to produce much. If they can't cover these costs using existing net worth, they exit and cease production. They may also exit from an inability to have profitable participation from the lending bank. The bank must pay a monitoring cost upon failure to pay. Firms can save net worth or pay dividends. Firms take out debt if their internal net worth is insufficient given their productivity. However, low net worth can limit future production and borrowing capacity, increasing borrowing costs and potentially forcing exit. Productivity has a persistent component which has a tendency to revert to the mean. The model asserts that higher productivity firms, although more sensitive to credit constraints due to larger production needs, are generally more resilient because they build net worth faster. Yet, credit constraints raise the likelihood of even these high-productivity firms exiting, which dilutes the cleansing effect of recessions (where ideally only lower-productivity firms exit). Osotimehin and Pappada use value function iteration to find steady-state firm dynamics in both frictionless and credit-constrained economies, revealing that net exits rise by 1.53% with credit frictions compared to 1.44% without, while productivity gains drop from 0.48% to 0.43%. Given these decision rules, they test various scenarios in a simulation to follow with constant amount of firms to enter, adjusting distributions of net worth and productivity, showing that stronger correlations between net worth and productivity lead to higher exit rates among low-productivity firms, enhancing the cleansing effect. Alternatively, increasing financial shocks disproportionately affects high-productivity firms, further reducing the cleansing impact by forcing out firms that would otherwise survive, similar to the weaker cleansing observed during the Great Recession. While the model explains how credit frictions dampen productivity-enhancing reallocation, it depends heavily on assumptions about net worth and productivity distributions and omits any sophistication in labor and demand-side factors. To address differences observed between Europe and the U.S. during the Great Recession, the authors suggest variations in firm net worth or shock severity could be responsible, but they focus on the U.S. Some issues with the results are that they don't have spiky enough initial behavior following the recessions and the effects are not very prolonged. The paper serves as a useful theoretical framework to highlight how credit constraints alter reallocation patterns in recessions, but I believe one could do a lot more using a similar framework.

This literature began with the idea that economic growth partly results from removing low-performing firms and reallocating their resources to more productive uses. During recessions,

when demand drops, less productive firms are expected to exit due to insufficient sales, allowing their capital and labor to be reallocated to more efficient firms. However, constraints can lead to the exit of not only low-productivity firms, potentially disrupting efficient reallocation. Key factors affecting reallocation include credit and labor constraints. Credit frictions are significant because, especially in recessions, denied credit can force firms into expensive debt servicing and cost-cutting, worsening exits. Hsieh and Klenow (2009) and Oberfield (2011) highlight capital reallocation's importance during recessions, while Caballero and Hammour (1999) argue that credit constraints impact reallocation more than labor constraints. Gamberoni et al. (2016) and Foster, Grim, and Haltiwanger (2013) show that firm-specific shocks significantly influence misallocation. Osotimehin and Pappada (2016) also show that credit frictions lead to the exit of some high-productivity firms by credit constraints which often affects high productivity firms, thus dampening the "cleansing effect." Aggregate shocks typically push low-productivity firms out, but if credit constraints bind for high-productivity firms, they too may fail. This effect leads to worse productivity following larger financial constraining recessions. Recession impacts vary by economic conditions. These models, however, often lack inter-firm dynamics, ignoring contagion or crowding-out effects. None include international variables, and firms in these models react passively to shocks, missing the active timing of common policy changes in business cycles (e.g., debt in low-interest environments). Even Caballero and Hammour miss out on some of the sharper immediate impacts as well as lagged impacts. Metrics for measuring reallocation and productivity vary, from unemployment changes and firm exits to inferred TFP changes and the best marginal revenue factor productivity as compared to the observed dispersion measures. Cleansing intensity measures the focus on productivity changes relative to net firm exits, though this can vary by firm characteristics and capital-labor allocations. Overall, the literature agrees that recessions generally lead low-productivity firms to exit but questions remain about proper high-productivity exits and post-recession creation rates. More research could investigate sector-specific reallocation effects, firm characteristics beyond size, and closer data fit in specific recessions. The Osotimehin Pappada model seems to me to be most flexible to be altered to accommodate these changes. I aim to bring more features to a similar model that can help to explain both the spiky early behavior of destruction and lagging creation in a better wait to fit the data. I believe a more timed response to aggregate decisions may help in this and to introduce more heterogeneity of firms. //

Section 2 - Empirical Analysis

The Osotimehin and Pappada (2016) model suggests that productivity can improve during recessions because it's primarily low-productivity firms that exit, rather than financially constrained but efficient firms. In contrast, Caballero's models indicate that constrained firms—often the more productive ones—are forced to exit, thus reducing overall productivity during downturns. The Osotimehin-Pappada model features firms that use single-period debt contracts to fund cap-

ital and cover fixed production costs, with entry based on profitability for firms with sufficient net worth and productivity. Firms exit due to either low expected continuation profits or lack of financing due to poor productivity draws. Caballero's approach, however, relies on an equal distribution of wealth across potential entrepreneurs; entry depends on whether a firm's productivity make entry profitable, while exit results from unfavorable productivity shocks that prevent further borrowing. Both models simulate firm dynamics with external aggregate demand shocks, ignoring more detailed factors. But the different assumptions on entry and exit criteria lead to different outcomes. Osotimehin and Pappada assume a positive correlation between net worth and productivity through their base assumptions on their distributions, which shifts exits toward less efficient firms, improving reallocation outcomes. They also do a simulation based upon optimal policy choices to determine an impulse response function. In contrast, Caballero's framework does not assume or force this correlation, making financially constrained exits more likely among productive firms. These models illustrate varying approaches to contracting, investment, and entry, but broader firm dynamic models used in macroeconomics could offer alternative perspectives on creative destruction by incorporating different assumptions on firm behavior and market interactions.

This literature has been mostly examination of macroeconomic changes effects on efficiency and not so much effort towards examining what is happening within or between industries. It could be that each industry is more or less affected by each type of recession and firm differences may be better described than a single productivity parameter. When there are more financial shocks perhaps capital reliant industries suffer more. Maybe industries with market power issues and high barriers to entry suffer in productivity after small firm failures. In this paper I aim to look for these differences in responses to reallocation during recessions using some regressions influenced by Gamberoni, Giordano,Lopez-Garcia 2016 and Foster Grim Haltiwanger 2013. I use a different dataset, than the original in Foster Grim Haltiwanger, and a different measure of efficiency. I decided to add in another measure of cleansing intensity to the regressions from the Osotimehin paper. I try to determine cumulative effects of recessions which has not been attempted in such a framework. I use firm data from Compustat which has not been used. I also examine differences between sectors. There has been some examination comparing services and manufacturing in Gamberoni Giordano Lopez-Garcia where they see that capital misallocation has been worse in services. They calculate MRPK and MRPL for a few sectors but don't look into factors influencing it. The data used has often focused on only manufacturing firms as was the case in Foster Grim Haltiwanger. Compustat data includes public firms only but there is sector diversity. There are several measures of efficiency of factor allocation that have been examined in determining effects of creative destruction. A popular favorite is the dispersion in the Hsieh Klenow 2009 marginal revenue products for each factor which was used in Gamberoni, Giordano,Lopez-Garcia 2016 paper. This measure relies on assumptions of common marginal costs, monopolistic competition, and cobb-douglas production which eliminates differences in labor productivity within industry. There are other similar

efficiency measures such as the Olley Pakes 1996 measure of factor productivity using productivity relative to the industry. There is also the Petrin Sivadasan 2013 measure of the wedge between marginal product of a factor and marginal cost. Each of these have been used for robustness in papers of allocative efficiency. These are good for focusing on the efficiency of allocation in a specific factor of production but the economy or an industry uses multiple factors so it is more likely accurate to measure allocational efficiency using a measure with all of them. In my analysis I choose to use the change in allocative efficiency as defined in the 2020 paper "Productivity and Misallocation in General Equilibrium" by Baqaee Farhi. This measure assumes markups are the only distorting wedges and that production functions within an industry are alike. Cost functions can vary among firms. The paper has a decomposition of changes in log output stating that it is equal to the changes in technology and the changes from the reallocation of shares of resources among users. It has two parts, one of changres coming from markups and the other of changes in factor shares. Then in order to determine what a cumulative effect would be after a change in factor reallocation or a recession I regress again using a 3 year change in allocative efficiency. I am more concerned about cumulative effects because the creative destruction process has a period of destruction followed by a creation period and both are important for knowing whether the recession was good or bad for efficiency. NBER says a typical recession lasts 11 months so one year should capture much of the destruction and the time following it should be capturing creation. I then calculate cumulative changes in allocative efficiency for 32 of the sectors for which I had shared data among the required variables. The Foster Grim Haltiwanger regressions use cycle changes which they measure using changes in unemployment, changes in TFP, a recession dummy, and the two way and three way interactions of these. The Gamberoni, Giordano, Lopez-Garcia regression uses changes in sales, regulations, demand uncertainty, changes in costs of credit and a recession dummy. Both of these regressions try to control for factor changes, some kind of market changes, and the recession. The Latter uses some extra conditions on demand and lacks changes in labor. I choose to use a control focused on productivity. I tried TFP initially but it wasn't as influential as when I normalized the TFP changes by net exit rates as was done in Osotimehin Pappadà with their cleaning intensity measure. So rather than just changes in TFP it is the change in TFP for the year's level of net firm exits. This helps separate away from the firm distribution. I identically control for unemployment changes using data from the BLS. I didn't have good data for changes in costs of credit for the firms which may have helped better explain capital effects. I had changes in per period debt which I deflated to 1998 prices. Then I use a dummy for the recessions in my data as defined by NBER and interacted it with the changes in the factor variables unemployment and debt as was done in Foster Grim Haltiwanger. The regression specification I used then is

$$\Delta\text{Allocative Efficiency}_t = \alpha + \Delta\text{Unemployment }_t\beta + \Delta\text{ Debt }_t\gamma + \Delta\text{Cleansing Intensity }_t\delta$$

$$+\text{Recession }\epsilon + (\text{Recession * Unemployment }_t)\zeta + (\text{Recession * Debt }_t)\eta + \varepsilon_t$$

I did this one once for the whole compustat economy and then switched to the cumulative changes over 3 years once more and again with each of the sectors. I used the years 1998 to 2015 because it was in common among the compustat data, the BEA data for depreciation, the BLS goods deflator data, and the census firm exit data. I drop data that has no entries for the required variables, ones that give me divide by zero results, and I winsorize the firms with markups outside 2 standard deviations. After this all I had 4740 observations remaining. I started by using the BEA sector definitions which are primarily popular 3 digit NAICS industries and then adjusted the compustat codes and Census firm exit codes to match these as close as possible. There were 32 total sector regressions after these adjustments. The markups used in the allocative efficiency measure were using accounting profits for simplicity. The accounting profits used operating income before depreciation and then subtracted away depreciation using the BEA depreciation figures and property plants and equipment. When calculating the allocative efficiency term using total compustat economy sales for output. The labor share was using employment expenditures over sales and the capital share the residual. Then to get the firm TFP measure I used in calculating the cleansing intensity I followed the method of Baily, Hulten and Campbell (1992) as it was in the Foster Grim Haltiwanger paper. In the cleansing intensity calculation I use average TFP for the whole economy or for the sector over the net exit rate for the whole economy or for the sector alone in the sector regressions. This TFP metric is defined to be the residual from logged real output subtracted by real logged capital multiplied by its factor share and the real labor expenditures multiplied by its factor share. For real output I used sales and deflated it by the PPI for the relevant industry. Some of these PPI datapoints had to be imputed. I calculated capital using the perpetual inventory method and deflated it by a capital goods deflator from the St. Louis Federal Reserve branch. I deflated the labor expenditures and the average debt by the PPI as well. The recession dummies were 1 in the years 2008 and 2001. My initial aggregate results are as follows in figure 1:

Figure 1

	Unemployment	Debt	Cleansing	Crisis	Crisis x Unemp.	Crisis x Debt
Aggregate	-.056*	.0069	0.000000904	.0195	.1672	-.0627
Aggregate Cumulative	-.0637**	-.1083**	-.00003679*	.0129	.8824**	-.3466** .

The allocative efficiency metric is percentage changes where .01 is 1 percent and so when you see -.056 as an effect from unemployment this is to be interpreted as a 1 percent change in

	Unemployment	Debt	Cleansing	Crisis	Crisis x Unemp.	Crisis x Debt
Mining	-.0092***	.0002	0.0007	-.0062**	-.0014	.003
Utilities	-.0002	-.0036	.00002928	-.0025	-.0007	.0045
Chemical Mfg	.0049	-.0074	0.0001	.0025	-.0003	.0037
Mineral Mfg	-.0004	.00047	-.0000369	.0002	.0008	-.0014
Food Mfg	.0005	.001	.0000442	.0008	-.0006	-.0033
Metal Mfg	.0073**	.0034	-.0002	-.0006	.0004	0.0018
Apparel Mfg	-.00045	.000007	-.0000024	-.0000216	.000000216	-.00001639
Metal Fabrication	-.0000256	-.0001	.00001984	-.0001	.0001	-.0008
Wood Products	-0000613	.0004	.0003	.0002	.0000277	.0000729
Computer/Electronics	.0036	.006	.0007	.004	.0064*	-.014*
Machine Mfg	.0017***	.0001	.0000339**	.0000729	.0017	-.0016
Paper Mfg	-.0007	-.0004	.0000463	-.0002	.003	-.0069
Electrical & Appliances	.0002*	.0000037	-.0002	-.0002	.0005	.0012
Petroleum/Coal	.0198***	.001	.0003***	-.0017	.0001	.0016
Car Mfg	.0037	-.0001	-.0012	-.0025	-.0084	-.0088
Wholesale	.0000677	-.0000297	-.00000439	-.00000415	.0000106	-.0000515
Air transport	.0039***	-.0001	.00004679	.0003	.0001	-.000015
Misc Mfg	.00005115	-.0000195	.0002**	-.0005**	-.0013**	.0001**
General Merchandise	-.001	.0000105	.0003	.0009	.0013	-.002
Rail transport	.001	-.0006	-.0004	-.000059	-.00000687	-.0000141
Water transport	-.000089	-.0000558	-.0000234	.0000339	.000003	.00009
Other transport	.0003	.00001339	-.0000151	.0006	.0001	-.0000889
Truck transport	-.00008	.000031	-.000001	.000032	.0002	-.0001
Telecommunications	.0124	.0093	-.0001	.0062	-.0035	.0105
Data processing	.0001	-.0002	0.0000053	.0002	.0000469	-.000038
Publishing	.0003***	-.000082**	.0000646	.000055	-.0005**	.0007**
Legal services	.0002	-.0001	0.0000084	-.000076	-.000008	.000008
Tax and Accounting	-.0004	-.000013	-.000018	-.0002	-.0003	.0001
Computer Services	-.0001	-.00000002	-.000015	-.0002	-.00002	-.000066
Admin/Support	.0002**	-.000087*	-.000009	.0003**	-.0007**	.0009**
Ambulance services	.000025	-.000067	-.000007	.000041*	-000011	-.000086
Accommodations	.0005	.0002	.000008	.0008***	-.000015	-.0006**
Food and drink services	.000073	.00008	.000009	.000073	.000008	.000009

unemployment leads to a 5.6% fall in it. When I put 1 asterisk I mean a significance of 90 percent and 2 asterisks is 95 percent and 3 is 99 percent. I think my result on allocative efficiency is more positive from the recession than the Baqaee Farhi figures because a good amount of the decline in allocative efficiency occurred at the end of 2007 and my recession indicator from NBER is 2008 only. If the data was higher frequency it may be a smaller effect. When I removed data before the 2001 recession there actually was a sign change in the interaction between changes in average debt and the crisis. So changes in debt during the great recession brought up the efficiency here. This may mean that the firms who perished from lack of credit were actually of a lower level of productivity. Then when including the other recession it became more of a negative thing for productivity which might be more fitting of the credit constraint view of Barlevy or Osotimehin Pappada. A negative cost of credit effect on MRPK is observed in the Gamberoni et al paper as well. The effects on allocative efficiency were weaker than in the 3 year cumulative version. I think there might be an issue of limited data since I only go from 1998 to 2015 but it could be that much of the effects of these factor changes are more drawn out instead of immediate. If

the data was more frequent than annual it would have more accuracy on timing. Unemployment changes dominate effect sizes here and in the regressions for each sector. It seems in normal times unemployment is bad for efficiency but in a recession the sign changes and it becomes a positive and strong force for allocative efficiency. Cleansing intensity was lightly significant and a negative influence. I think that cleansing intensity is a negative influence on cumulative efficiency from the great recession data primarily. It was shown in the Foster Grim Haltiwanger regressions the great recession had worse destruction and less creation than usual so perhaps the cumulative effect was negative. The second figure describes the regression results for each of the sectors that I had complete data for:

There are quite varied effects for each variable for each sector and not a lot was significant with dataset. My data appears to be more skewed towards manufacturing, there wasn't enough data for some important things like finance or healthcare or education. This compustat data is for public firms so this can skew things and the firms are likely larger. Perhaps if I had more data and could afford to limit the analysis to smaller firms the effects would show to be larger as is seen in Foster Grim Haltiwanger. The shocks in the recessions of the 2000s are both more financial crisis so this also affects the results. The crisis was significant for mining, machine manufacturing, miscellaneous manufacturing, administrative and support services, and in the accommodation industry. It seems to be more negative for manufacturing and positive for services. The unemployment variable is the most dominant effect again. Notice that some of the more service type industries had more significant effects like accommodations, publishing, and administrative. It seems unemployment has a very heterogeneous effect among industries. It is strongly negative for the whole economy outside of recessions but you get positive effects for industries like petroleum, telecommunications, chemical manufacturing, air transport, and metal manufacturing. Many of those are capital intensive. It appears more labor intensive industries had negative effects of unemployment when in a recession. Most of the technology related industries have positive effects from the reallocation with the exception of computer services. It appears that there are positive or near zero effects from changes in debt or the interaction of debt with the crisis on allocative efficiency in more labor intensive industries. Then you see negative effects from the debt changes in some more service like industries and capital intensive things. In the aggregate it is fairly strongly harming efficiency so it must be driven primarily by some of the larger effects in certain sectors. Some of these effects could be lagged at varying rates across firms. Labor intensive firms seem less affected by the recession but are affected by aggregate unemployment trends. And clearly a capital intensive firm would be more harmed by higher borrowing costs and are more credit constrained. Cleansing intensity also has a varied effect but it isn't very significant. The capital intensive industries have high adjustment costs and some barrier to entry problems which might contribute to debt and cleansing results. So from these relationships I draw a few hypothesis. Crisis and debt constraint effects seem to affect capital firms more. The factor intensive firms are more constrained by their factor intensity and are negatively affected from

forced factor reallocation in it. Some industries such as complex services and technology seem to get affected strongly by factor reallocation and it may be because of being more constrained by both labor and credit. Crisis effects seems to be more important in industries that have more adjustment frictions, barriers to entry or market power issues. Though my data is limited, much of these results line up with the literature even under my different dataset and alternative variables of efficiency, confirming the robustness of older papers results. I use some of these facts to help inform how to improve the model to consider those hypotheses.

Section 3 - Model

If firms that have more intensive usage of one factor are harmed more by forced reallocation in it, then market distortions or regulation in that factor would harm them more. Things like credit constraints, increased lending scrutiny, high adjustment costs, or abnormally high interest rates would limit efficiency in capital intensive industries. Labor market regulation, searching frictions, strong job match quality, and unionization all might harm allocative efficiency in labor-intensive industries. An industry could benefit from exits if there is too much capital or labor being used by unproductive firms. Likewise, from entry if productive firms are constrained. Policies protecting incumbent firms likely worsens the first issue, and policies making it more difficult to enter worsens the second issue. To get these heterogeneous effects in firms with different dependencies on the factors of production you couldn't only differentiate firms based on productivity or net worth as Caballero Hammour do or Osotimehin Pappada do. If they only get heterogeneous debt contracts based on each of these differences, then it won't generate this behavior. Job flows data from Caballero Hammour 1999 suggests creation of jobs should spike downward initially, up and then smoothly slowly curve back down in recovery. The destruction spikes up and down initially, then smoothly falls back to trend. In Gamberoni Giordano Lopez-Garcia the graph for changes in MRPK dispersion over time in Europe shows a steeper decline during the recession than it returns, but the shape isn't very defined since observations are annual. The MRPL dispersion had steeper declines and return after than MRPK. This European trend of dispersion worsening over time is probably unrelated to the normal business cycle trend, but the responding movements during the recession are relevant. Allocative efficiency changes in Baqaee Farhi are modest declines from the 2001 recession and then a large improvement following it. Then the great recession had a steep decline and a steep recovery that was lower, and then it stagnated with a slow rise. So a model needs to have firms cutting a lot of labor in downturns and quicker returns if it is dominant. To think about how one could structure a firm dynamics model in order to generate these desired effects, I am going to base it upon the Osotimehin Pappada model which is highly influenced by older versions like those of Caballero Hammour. I believe it will be easy to modify to account for various labor and borrowing frictions.

To do this, I propose some changes to the Osotimehin Pappada model as follows. The model

has no labor, but I add in a single identical unit labor to the problem with the same labor hold-up problem from Caballero to make it less dependent on capital and lessen its effects from shocks. To allow for a less capital dependent firm, the hold-up problem adds a share of production going to workers and so production is reduced by $(1-\gamma)$. Then the capital factor share α is also changed to be lower for labor-intensive firms to add to the heterogeneity. To change the capital decision so that it may be extra spiky, I propose to allow for debt contracts that can be longer than 1 period. They allow an option to extend the current lending rates for an additional period. The intermediary still must expect to want to participate next period. I allow the risk-free rate to vary with the aggregate shock to reflect some monetary changes. With varying interest rates in the simulated economy, the firm would be expected to take out longer loans if they expected future rates to be higher. The intermediary will consider the aggregate economy, firm type, firm productivity, and the firm's net worth. Firms may then time the macroeconomic circumstances and see more firm creation following a recession.

There is a firm which maximizes their dividends after producing each period and its continuation values. They can exit if the conditions are such that the continuation value is insufficient as compared to liquidating and distributing the dividends. The firm has a persistent productivity parameter which changes each period stochastically θ. The firm will have production scaled by stochastic aggregate demand Z, it has two states and identical rates as in the original paper. Alongside this is a risk-free rate r for each Z. There is also non-persistent random shock ϵ. The ordering of events is as follows. They enter each period with the net worth retained from the previous period and must choose how much capital they would like to borrow. It will depreciate δ after production. They can use the net worth "e" to help fund it. The firm borrows k + c -e from an intermediary before knowing the new ϵ , where c represents a fixed cost. The intermediary must expect to earn more than the risk-free rate on this to participate. The intermediary must also pay a monitoring cost on capital μ in the event that there is a default. After production, they learn the next periods, persistent production and aggregate production. They must choose dividends and exits at this point. Together this is the participation constraint

$$(1+\tilde{r})(k+c-e)(1-\Phi(\tilde{\varepsilon}))+\int_{-\infty}^{\tilde{\varepsilon}}\left[(1-\gamma)Z(\theta+\varepsilon)k^{\alpha}+(1-\delta)k-\mu k^{\alpha}\right]d\Phi(\varepsilon)\geq(1+r)(k+c-e). \quad (1)$$

This $\tilde{r}$ is the borrowing rate, regular r is the risk-free rate. This ϵ is normally distributed, thus the terms $\Phi(\bar{\epsilon})$ represent the CDF point where the ϵ is at the cutoff of where the firm defaults. So the left side is expected intermediary profits and the right side is the riskless outside option. The profits are coming from the expected profits of the paying back of the loan and the expected liquidation value if they fail. This is similar to his constraint but given that my borrowing cost differs if they take different contracts, I can't simplify this further. Using this same constraint, if we assume the intermediary could maximize profits using their own choices of capital and default thresholds, there exists a cutoff $e_b(\theta, Z)$ which can be solved for with the e on the right side of the

inequality. If the firm doesn't have that amount of net worth, there can be no profitable contracts offered. The default threshold on the ϵ can be obtained by the participation constraint at each possible combination of capital, equity, and productivity. It will be the remaining level of ϵ which brings equality of the outside investment option and lending. For convience in simplifying the firm problem to come, I use this default threshold where they can't produce enough to pay. It defines the $\tilde{r}$

$$(1-\gamma)Z(\theta+\bar{\varepsilon})k^{\alpha}+(1-\delta)k=(1+\tilde{r})(c+k-e). \tag{2}$$

We combine that with our end of period net worth q.

$$q=\begin{cases}(1-\gamma)Z(\theta+\varepsilon)k^{\alpha}+(1-\delta)k-(1+\tilde{r})(c+k-e) & \text{if } \varepsilon>\bar{\varepsilon},\\ 0 & \text{if } \varepsilon\leq\bar{\varepsilon}.\end{cases} \tag{3}$$

To get this simpler one

$$q=\max\left[(1-\gamma)Zk^{\alpha}(\varepsilon-\bar{\varepsilon});0\right]. \tag{4}$$

Putting these together with the firm's recursive value function as in the original model we have

$$V(e,\theta,Z)=\max_{k,c}\mathbb{E}\left\{\int\left[I(q)q+(1-I(q))\max\left[q,\max_{e'}\left(q-e'+\beta V(e',\theta',Z')\right)\right]\right]d\Phi(\varepsilon)\right\} \tag{5}$$

with:

$$I(q)=\begin{cases}0 & \text{if } q\geq e_b(\theta',Z'),\\ 1 & \text{if } q<e_b(\theta',Z')\end{cases} \tag{6}$$

subject to:

$$(1+\tilde{r})(k+c-e)(1-\Phi(\tilde{\varepsilon}))+\int_{-\infty}^{\tilde{\varepsilon}}\left[(1-\gamma)Z(\theta+\varepsilon)k^{\alpha}+(1-\delta)k-\mu k^{\alpha}\right]d\Phi(\varepsilon)\geq(1+r)(k+c-e), \tag{7}$$

$$q=\max[(1-\gamma)Zk^{\alpha}(\varepsilon-\bar{\varepsilon}(k,\theta,Z,e);0], \tag{8}$$

$$\varepsilon_b(\theta',Z')\leq e'\leq q. \tag{9}$$

This indicator determines whether the firm continues. Clearly if one exits you set e' to zero and get q, continuation equals zero in this case. The choice of e' is to maximize net dividends plus expected continuation values. The e' decision follows the knowledge of θ' and Z' so expectation is over temporary shocks. As such, for easier usage in the value function iteration computation the

author further rewrites the value function as:

$$V^1(e,\theta,Z) = \max_k \left\{ \int \left[\max_{e'} \left(q - e' + \beta \mathbb{E}\, I(e') V^0(e',\theta',Z') \right) \right] d\Phi(\varepsilon) \right\}. \tag{10}$$

My firm problem mostly remains the same as in the original paper. The notable differences are in equation 7 which retains the interest rate paid by the firm, which will be necessary for determining what interest rate they could extend into the next period. If there is no existing contract from the period before, you can substitute equation 2 into the equation 7. Another caveat is that equation 8 is only for a firm which hasn't come out of a period which had previously taken a contract, it would be equation 3 otherwise due to the unusual lower lending rates. Then my additions of the heterogeneous α and γ amongst firms depending on their dependence on capital or labor. The default epsilon can be determined through the k choice, so it was redundant. The indicator represents when they will be exiting or remaining. They must retain a certain amount of net worth or the intermediary will not participate and therefore they have to exit e_b. The intermediary must expect participation in every period, they don't consider cumulative expected profits over two periods, which would allow for offsetting losses. In short, the periods start with choosing your debt contract for the next period, then you choose capital to produce. Then you observe the ϵ, θ', Z'. You produce, and pay off your debt for the period, or you are liquidated if you can't pass the net worth constraint in the next period. Finally, choose your level of net worth for the next period or keep it all and exit.

The choices of debt contracts must be made based on the firm's expectations of future net worth, productivity, and aggregate states. In doing this, they compare the expected value function of the normal 1 period contract to the expected value function that would come from carrying over the current period's interest rate into the following period. This decision is made before they produce and learn θ' or Z'. In that next period they could take out another extended contract, but it would be with the interest rate that would have been paid in that new period and not using the old contract's one. This leaves multiple value functions we must calculate. Calculate the expected value after no contract. Then you must calculate the expected value where the contract is used. It also influences your net worth threshold required e_b because this indicator depends on intermediary participation in the following period. If it were superior to extend the rate, then we see our continuation value reflecting that expected return rather than the one of a single period contract in equilibrium. So it too must be calculated with that incorporated in the value function of the contract extending decision. This continuation value too may vary based on whether it is expected to open another contract in the following period or not. Adding to the computational burden.

Next, just as was done in the original paper, we do a simulation to see how the firms act under an aggregate shock. First, I simulate some periods up until it reaches a steady state distribution of firms. Then I introduce a new path of shocks that reflects this one time aggregate shock effect,

followed by the high Z states afterward. There will be a constant amount of potential firms which can enter if they get favorable draws of productivity and starting new worth. Each of these potential firms independently draw their θ and net worth. The net worth is uniformly distributed zero to 9.7 which was what the original author used for the sake of matching his lowest possible dividend threshold. The θ are drawn from the stable distribution that is determined through his specified transition matrix on its AR(1) process with persistence.

$$\ln \theta' = \rho_\theta \ln \theta + (1 - \rho_\theta)\eta_\theta + \varepsilon_\theta, \text{ with } \varepsilon_\theta \sim \mathcal{N}(0, \sigma_\theta). \tag{11}$$

This matrix is discretized with the Tauchen (1986) method. He chooses the variance on this noise component based on getting a desired range of observed firm thetas. This range comes from Del Gatto et al. (2008). It had a mean of .3. The temporary shock ϵ was normally distributed with a variance he chose to match up with the default probability 1% which is found from Carlstrom and Fuerst (1997) estimation. His Z had two states, 1 or .97. The transitions were chosen to reflect a 3 period average time to transition as is seen in the business cycle. When the firm considers its entry, it looks to the optimal choice variable for capital. Then it looks to its expected dividends, and it will enter if it is profitable. Then we run through each of the existing firms. They choose contracts and capital as per the steady state policy and draw their new shocks. They pay back the loan and choose a new net worth. If the intermediary does not want to participate next period on account of low net worth and or productivity, the firm must exit. Likewise, if the firm finds it better to keep their dividends and ignore a low continuation value, then they would exit. It goes on to record exiting behavior, entry, average levels of productivity, net worth, and capital after a shock on Z. I maintain his calibrations on the parameters with 2 exceptions.

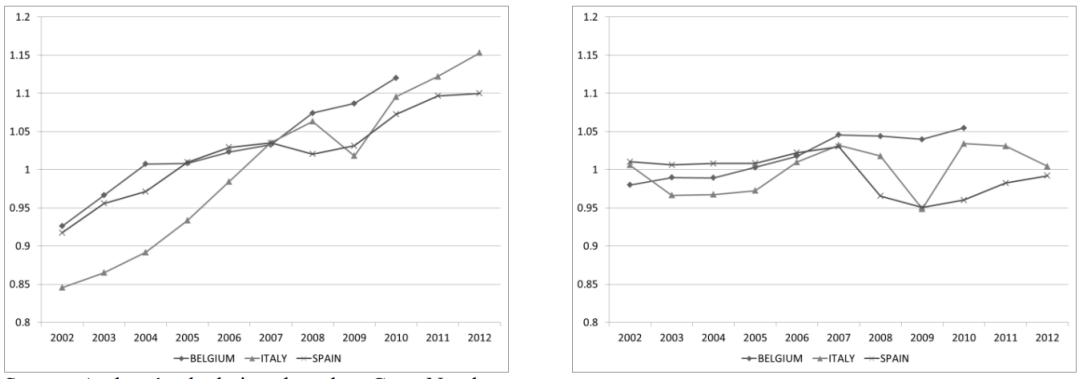
I chose to allow the risk-free rate to fall in the recession state to 1 percent, reflecting stimulative monetary policy. My c variable had to be much larger than his because my labor payments reduced output and contracts made it more appealing to stay. I would have had far lower exiting rates if not doing so, which was the whole purpose of its calibration. His returns to scale was chosen because of a Hennessy Whited (2007) paper findings. I left his .7 for the capital intensive firm and reduced it slightly by .05 for the labor firm. I chose a difference of .1 and in .15 in the labor holdup production reduction parameter to have a similar sized distortion in the α parameter. The amount of capital or productivity will change which effect dominates. The productivity parameters were meant to fit results of two separate papers that looked at the ranges in TFP in the Italian and American economies. The monitoring costs were chosen to representing about 10% of the firm's capital based on a paper by Andrade and Kaplan (1998).

Parameter	Symbol	Value
Discount factor	β	0.956
Risk-free rate high	r	0.04
Risk-free rate low		0.01
Depreciation rate	δ	0.07
Returns to scale capital intensive	α	0.70
Returns to scale labor intensive		0.65
Aggregate productivity high	Z	1
Aggregate productivity low		.97
Persistent productivity, mean	η_θ	-1.2591
Persistent productivity, volatility	σ_θ	0.1498
Persistent productivity, persistence	ρ_θ	0.9
Fixed cost	c	4.5
Idiosyncratic volatility	σ	0.3
Monitoring cost	μ	0.25
Entrants net worth upper bound	$\bar{e}_{\text{entry}}$	9.7
Labor intensive firm labor reduction	γ	.15
Capital intensive firm labor reduction		.1

Section 4 - Results

Some of the factor productivity measures I will use to relate my results would be from the Gamberoni et al. paper as seen in these figures of some popular European economies. These are marginal revenue products of capital and labor. I am able to record changes in average firm capital. The firms in my version when in existence have a single unit of labor, and it isn't a choice, so labor decisions here would just match the net exiting rates.

Figure D2. Average dispersion in MRPK and MRPL
(full sample data; weighted averages)



Looking at our primary recession depicted, in 2008, we see this spike downwards and a quick return to previous trends. But capital was slower to return. The second set of graphs come from the Caballero papers. CC being a firm creation rate, and DD of destruction, Q of the industrial growth over that period. These were observed job flows on manufacturing firms, not actual firms created or destroyed.

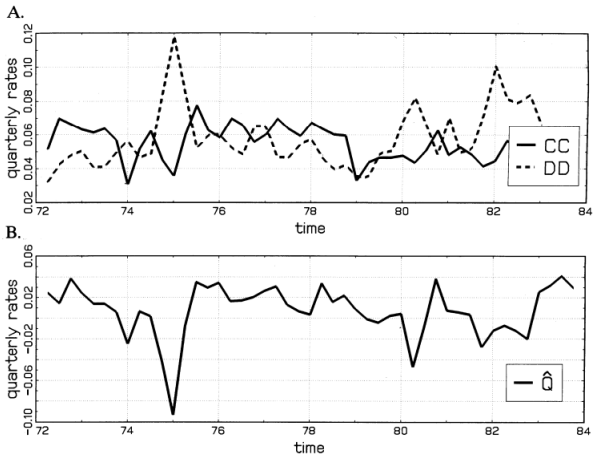
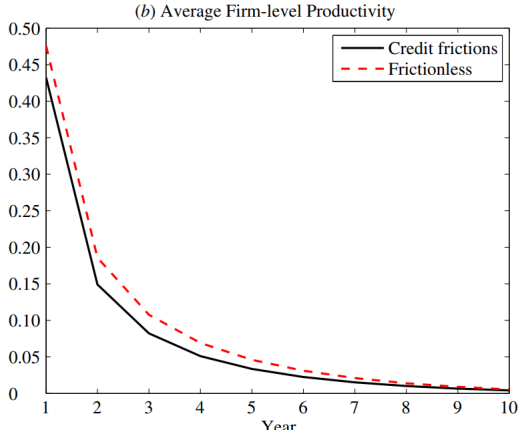
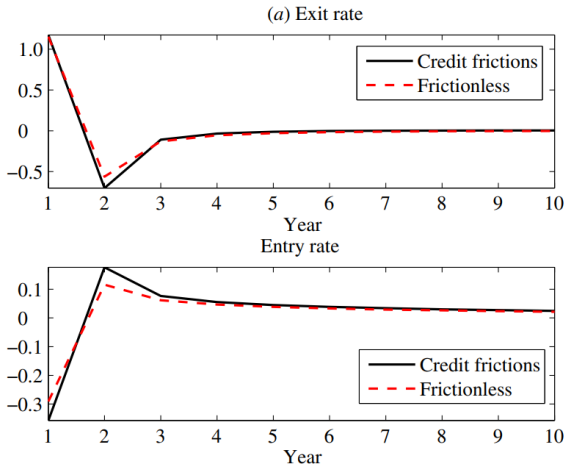


FIGURE 3. A) JOB CREATION AND DESTRUCTION IN U.S. MANUFACTURING; B) INDEX OF INDUSTRIAL PRODUCTION (RATE OF GROWTH)

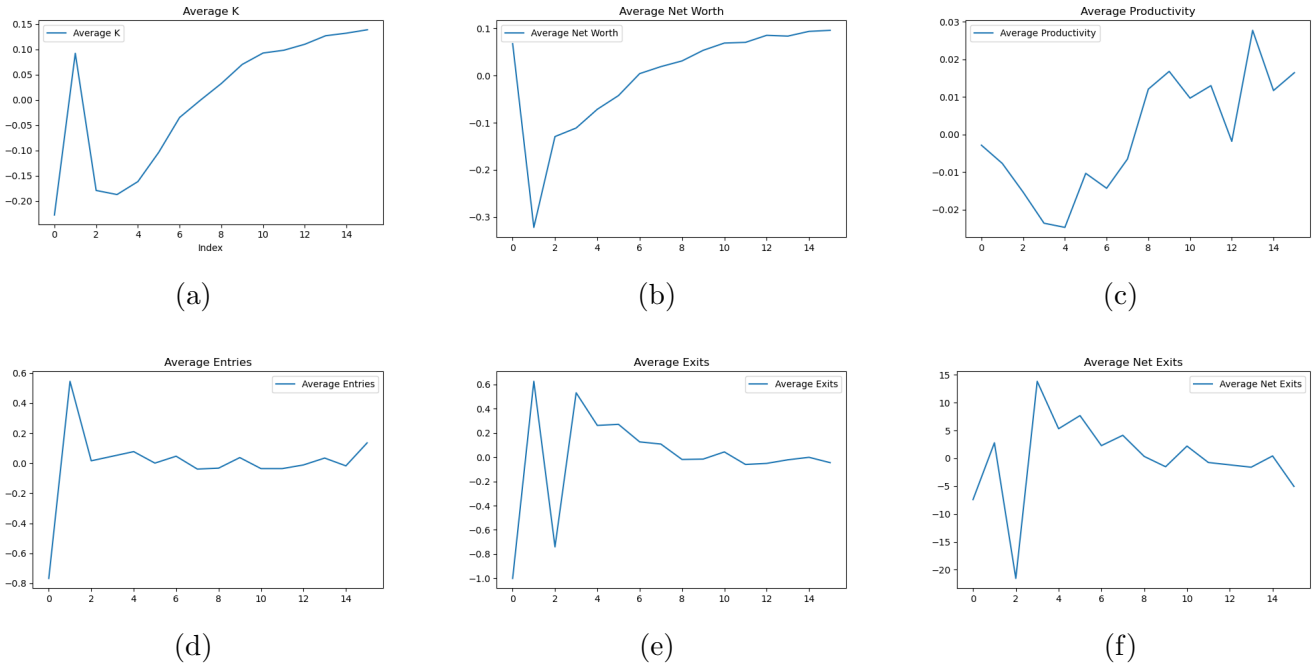
Focusing in on the 1975 output drop here we can see creation falls during the drop and then spikes higher than usual before it slowly returns to trend. The firm destruction spikes high during the drop. Then we see a bit of lower losses in the years to come as new firms enter, and afterward back to trend. In the Papadas Osotimehin paper this average persistent productivity following a recession shock is shown here.



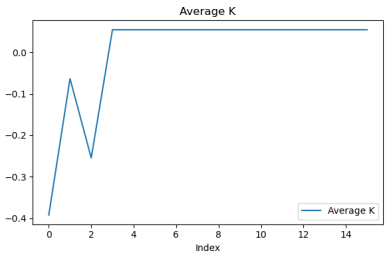
It improves and then returns to steady state slowly. The improvement being from knocking out low performing or unlucky firms, as they can't produce enough to satisfy intermediary participation and give a high enough continuation value. So their prediction was a spike that slowly declines. Finally, I show you here that paper's entry and exit responses for the final comparison data.



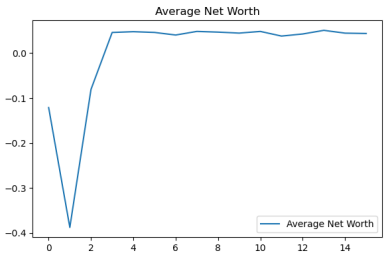
Here we see the initial spike and quick return to normal on each. This differs from the other creation and destruction data from Caballero. Firstly, it doesn't have a similar decline as what we see here after the recession of 1975. These impulse responses are nearly mirrored, which is not the case in the other paper results. For Caballero the creation rate does rise and, though falling after, it remains high until another recession. In general, it should have more drawn out effects with the entry lagging exits. They also overstate entry and understate exits.



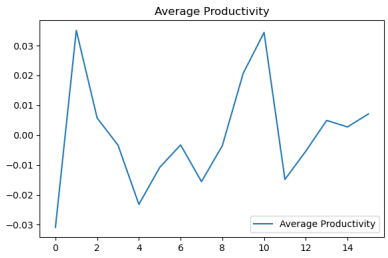
Capital intensive firm's response to aggregate shock



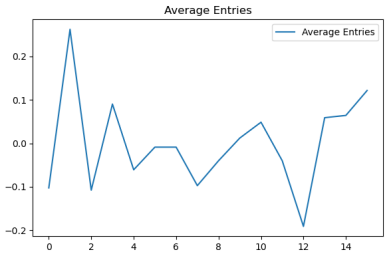
(g)



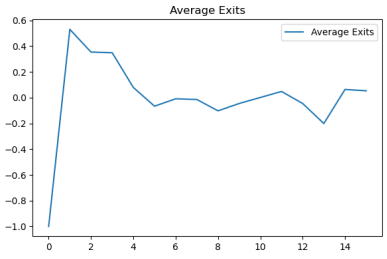
(h)



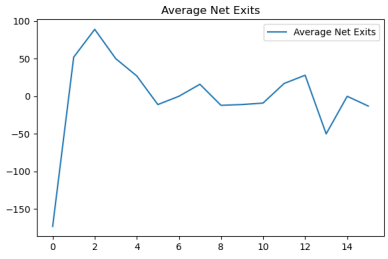
(i)



(j)



(k)



(l)

Labor intensive firm's response to aggregate shock

One first note about my graphics in these figures is that due to the larger amount of computation required for my model, I was required to make some sacrifices to make it feasible. By reducing the state spaces available in my grids for capital, productivity and net worth I expect that there are larger changes from period to period and so it will be much less smooth than it ought to be. I have 4 states for both productivity variables, capital, and net worth. The transitions maintain the original designs probabilities. Due to low options of states offered, you see it to be fairly unlikely to change persistent productivity as time progresses. Also with fewer different temporary shocks, it became much more likely to have extreme shocks. Similarly, it would take significantly more compute to consider multiple lengths of a debt contract. Because of these changes the choices of the firms may look choppy in the simulation but assuming there were more states one should expect the graphs to be smoother after the first couple periods of the shock.

I used 2000 potential entrants per period to try to get meaningful averages. I then ran 5 separate simulations and averaged the results so that it would be less probability dependent and to take away from my issues associated with a small state space. The graphs are percentage deviations from the trend statistics. As in .01 representing one percent, 1 being 100%. Period zero is a high aggregate state that includes the firm behavior knowing the negative shock is now happening, so they may leave preemptively before producing in that shocked economy. The period one is when the shock occurs. And you see extra activity following that period due to extended contracts ending at that time from the shock and twin peaks. This would be more drawn out if they could take out longer contracts and lose that quality. Other things that could extend the mean reversion would be persistence parameter changes or longer recessions. First, I will go

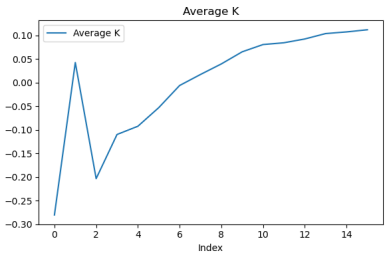
through my capital and labor averages among firms following the aggregate shocks.

The amount of capital I tried to keep similarly utilized among productivity's as in the original paper. You can see following the shock in the labor-intensive firms, they max out their usage based on the state spaces available. However, in the shape of the graph you can see the similar shape to what was seen in my first set of images from the Gamberoni paper. They record low marginal products of capital initially, then a fairly quick return to trend. So large decline in marginal productivity of capital, and then we see some increases slower to normal. In their graph there were some differences among different economies in speed of the return to trend, and you can see the bigger lag in my capital intensive firms, so I can show both behaviors. We can see the initial spike in capital usage is much larger for capital intensive firms. The labor-intensive firm does not see a very large spike in capital usage as compared to normal conditions. It took longer to return to the normal usage and following the return it didn't remain far above the average usage, following that I would predict that it would slowly return to steady. The labor case had more potential combinations of states which supported optimally using a contract. Likely from their less volatile changes in production and this appeals to the lender's profitability. Capital intensive firms benefit more from lower interest rates because they have a greater potential profit from adding capital. This means the intermediary is more heavily burdened with the cost of interest rate risk in extending them loans because it is more likely to lend them funds at far too cheap an interest rate and lose money. Instead they may choose to focus on short term loans due to this interest rate risk.

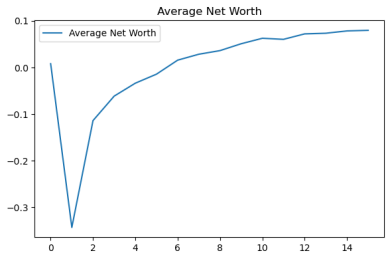
In my model labor is distributed 1 per firm so net exits matches my labor usage. Note that a negative net exit would mean higher entry. These changes were sharp as you can see, so each period brings a large block of similar firms dropping out or entering at once. This led to high changes in percentage terms, especially in labor firms. In the Gamberoni depiction of MRPL we see it doesn't really grow over time it just dropped and returned to the steady state, some nations more quick than others. There are longer returns to average in capital intensive firms because of their more frequent usage of the extended contracts. Higher creation would indicate a drop in MRPL. With capital intensive firms we see that no one wants to exit knowing the recession is coming because they will take advantage of lower interest rates. Then recession knocks out some firms and in the period following recession we see big entries. And then after this contract ends the firms which could only exist in the suppressed rates exit. This is as expected and it represents the more delayed return economies. In labor intensive firms it was more immediate and powerful. They are less likely to remain knowing a recession is coming. When it hits the worst of it is extended until their extended contracts end in period 2. The return is then fairly quick. The labor-intensive firms appear to not be as dynamic because their capital usage trends aren't as significantly changing. Entries are more drawn out and later for labor firms which better reflects the data. Exits have single hump due to less extended contracts. This seems similar to the conclusions I drew from the Caballero model. The labor-intensive firm reflects the expected

shock effects more similarly, which makes sense because that would be more firms in America and his graph represents job flows.

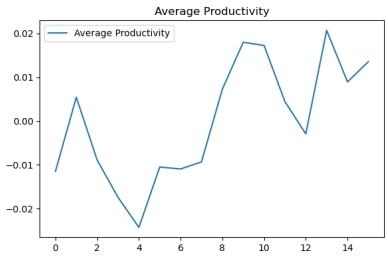
Aside from the choppiness of the actions due to a much smaller state space the general trends of these graphs seem similar to the desired comparisons seen in these other empirical data sets. But their data is over all the firms in an economy and not a single type. If you wanted more or less quick behavior you can adjust the prevalence of each type of factor intensity. This issue of state space may be a large part of the reason my impacts are so large if you considered it in percentages as compared to the original paper results. It causes a significant part of firms to drop out of the market when it should be a narrower range. Currently exits are high as compared to the author's 12 percent that was calibrated to the US economy. It can be improved by adjusting my fixed costs, or factor parameters, or adding more simulations to average among, and with a greater state space size. From my previous regressions of various sectors I saw better crisis effects and debt related effects on efficiency among capital firms. The labor firms efficiency changes were more driven by unemployment than crisis or borrowing. The unemployment would be most similar to net exits in my model. My productivity transitions were delayed and in the capital model it would require a longer timeline to see the return to the mean. Labor seeing a bigger swing in its returns and we see the delayed second peak at a similar time that we see capital reach its only peak. I believe my high exits is causing too many good firms to leave, and it muted some of the positive effect size on productivity improvements. The initial exits when entry comes it did bring productivity up and even more so for labor intensive firms. Due to the lower net exits, the cleansing intensity of capital firms was better here. The labor industries were less dynamic. So the productivity changes were coming more from changes in labor intensive firms but the capital intensive firms did time the market more and saw more drastic firm behavioral changes, including the delayed entry effect. Some other implications of the current model are that labor firms with their less volatile production could easier receive long term loans but they wouldn't always like to use them. The firms with high net worth and productivity were highly likely to benefit from a locked in lower interest rate. Regression to the mean was kind of strong in this productivity process from the sharp changes in temporary productivity shocks, so productive firms would experience stronger credit crunches on the long loans post the recession. In this model, the repeated short term loans are more representative of a variable rate loan. Similarly a low productivity firm could get more longer and fixed loans because intermediaries make more money from them. Due to the expectation of things returning to higher production after a recession you weighed continuation values greater and we saw more entrances.



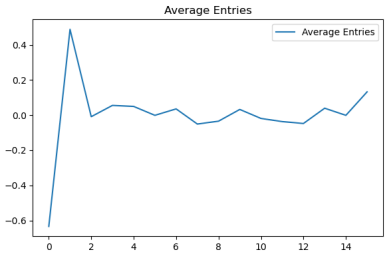
(m)



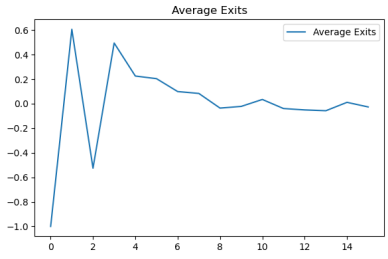
(n)



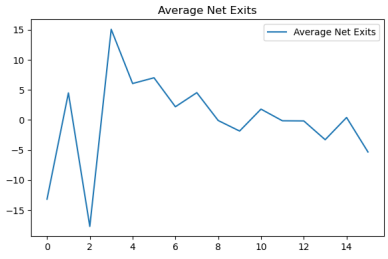
(o)



(p)

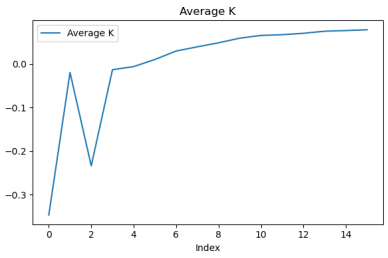


(q)

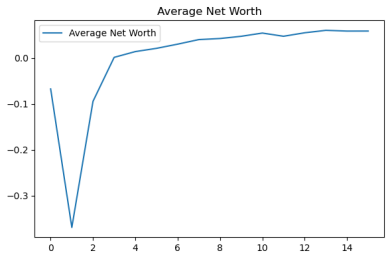


(r)

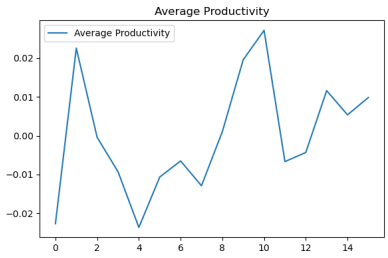
Aggregate economy response to aggregate shock 70% capital firms



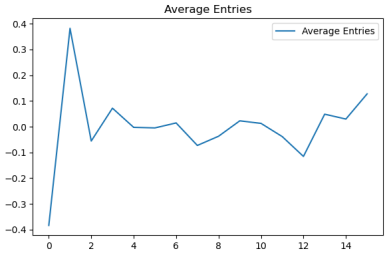
(s)



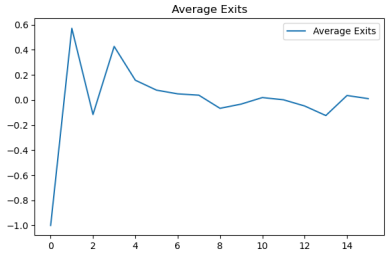
(t)



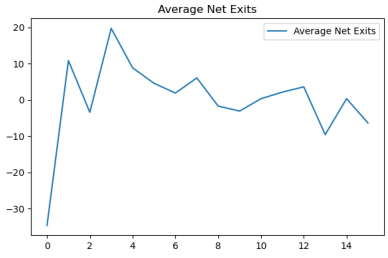
(u)



(v)



(w)



(x)

Aggregate economy response to aggregate shock 70% labor firms

Following this examination I decided to use these two firm type datasets to calculate roughly what it would look like in aggregate. I did it once with 70% capital, 30% labor. Once with 70% labor, 30% capital, which is probably more likely in many developed countries. Looking at the labor dominant economy we see better fits with caballero data on entries with exits a bit more drawn out than desired but this double peak disappears if they could do longer debt contracts.

The net exits and capital behavior seems to closer match the data of Gamberoni. Again, if we bring down exit rates through a different calibration we would see larger productivity gains and a less drastic net exit behavior which could be further calibrated as desired to match any desired country's economy. In these mixed sector economies we see the trends much clearer and accurate than before.

Some additions that would be worth exploring with this model would be more closely calibrating it to a specific economy and recession. I could try to opitimize my simulation calculation and value function iteration processes to allow for larger state spaces and longer contracts potentially. With better optimized estimation it maybe possible to show it with even longer debt contracts but I predict this just removes any double peaks we see and draws out the return to mean. It would be a more accurate comparison if I used some proper exit and entry data calibrated around some of the more recent recessions. I could closer examine the net worth shock idea that was in the original paper to further calibrate it towards recessions more tied to asset prices. Additionally, it could be useful to include a more complex labor choice in the production so that we could see any differences, and compare with job flow data. Or shock it to see how that economy is differentially affected by labor dynamics and how its effects interact in this recession. One could maybe re purpose this model to add elements of contagion between firm failures and represent various industry connections. More easily and maybe more interestingly, one could add some features to this model to see the effects of bailing out a critical firm and the resulting firm behavior.

Conclusion

The creative destruction literature initially focuses on cutting out the lowest performing firms and then its newly freed up resources are used by firms that are more efficiently serving the market needs. Early models have homogeneous firms that implement the state of the art technology and exit when others outcompete them at exogenous rates or demand shocks shift profits negative. Later we seem some stress the possibility that even with heterogeneous firms the credit frictions are driving a large part of these bankruptcies and can take away from productivity gains in such circumstances. it reveals that financial constraints don't just force exit among the lower productivity firms and they worsen new entry. Recessions have differing effects based on what occurred during it and the source, necessitating more complex models. In more modern models with output shocks they can show some of the features of firm creation but it doesn't closely match lagged effects. These models are stylized and there are many other factors in the economy that aren't considered such as international influences, monetary policy, labor markets and also the demand side. In an effort to better understand heterogeneity in productivity after reallocation, I used compustat firm data to estimate what was driving different sector's net result after a recession. My regressions were based on previous empirical papers that were concerned with reallocation effects of the great recession. My paper uses alternative data and some alternative measures that

mostly confirm the previous results. These effects weren't the strongest in the compustat dataset, but they helped to show the way which these factors influenced net firm creation under a crisis. I was lead to believe that when an industry is more intensively using one factor that it will be more negatively affected by frictions concerning that factor. That various inputs have separate shocks at times, and it may help explain disparate effects under each given recession. I adjusted a modern firm dynamics model to accommodate this idea through comparing firms with strengths in capital vs labor. I put in a longer duration debt contract and varying interest rates to more accurately describe monetary policy effects and dynamic firm behavior to see if it captures some of the creation variety. It was able to potentially accommodate the proper firm creation following a recession, and through properly weighting the firm types of the aggregate economy we could see a better fit. It can allow for more prolonged effects as well as sharp spikes of changes. It can help more specifically explain the transmission of monetary policy and the debt taking behaviors of firms. It would be an interesting exercise to calibrate this to match specific economies and look at fit during selected recessions. The model predicts greater productivity gains coming from destabilizing labor-intensive industry, but it isn't as efficient in doing so as in capital-intensive firms. It shows a new variety of credit friction coming from an intermediaries desire to not take on changing interest rate risks. This friction is worsened for volatile industries and may suppress firm entry for certain sectors. A more dynamic labor hiring decision could be useful for explaining different types of shocks and the entanglement of the crisis effects with unemployment. Using a sort of input output compatible framework or some mechanism with intermediate goods or financing coming from abroad you could describe international influences that might trigger firm exit and cascading effects from failures or industry related shocks. This could also be good to explain systemically important firms, financial liberalization, or trade. There could be shocks abroad or tariffs that drive up input prices and force a firm to exit or debt mismatch problems that make them susceptible to exchange rate fluctuations. This type of model can accommodate more features than it presently does, and this allows for more precise analysis of crisis and firm productivity. These modeling ideas could present new and potentially important avenues for explaining creative destruction. Shocks that could be measured to determine their relative influence and impact size to better motivate policies of recession fiscal and monetary policy.

Works Cited

Baily, M. N., C. Hulten, and D. Campbell (1992). Productivity Dynamics in Manufacturing Plants. Brookings Papers on Economic Activity 23(1992 Micr), 187–267.

Baqaee, David, and Emmanuel Farhi, "Productivity and Misallocation in General Equilibrium," Quarterly Journal of Economics, 135 (2020), 105–163.

Baqaee DR (2018) Cascading failures in production networks.Econometrica 86(5):1819–1838.

Barlevy, G. (2002). 'Credit market frictions and the allocation of resources over the business cycle', Journal of Monetary Economics, vol. 50(8), pp. 1795–1818.

Caballero, Ricardo J., and Mohamad L. Hammour (1991): "The Cleansing Effect of Recessions," American Economic Review, 84, 1350-1368

Caballero, Ricardo J. and Mohamad L. Hammour. 2005. The Cost of Recessions Revisited: A Reverse- Liquidationist View. The Review of Economic Studies 72, no. 2: 313-41.

Foster, L., J. C. Haltiwanger, and C. J. Krizan (2001, September). Aggregate Productivity Growth: Lessons from Microeconomic Evidence. In New Developments in Productivity Analysis, NBER Chapters, pp. 303–372. National Bureau of Economic Research, Inc.

Foster, L., Grim, C. and Haltiwanger, J. (2013). 'Reallocation in the Great Recession: Cleansing or Not?', Journal of Labor Economics, vol. 34(1), pp. 293–331.

Gamberoni, E., Giordano, C. and Lopez-Garcia, P. (2016). 'Capital and labour (mis)allocation in the Euro area: some stylized facts and determinants', Working Paper 1981, European Central Bank.

Hsieh, C.-T., and P. J. Klenow. 2009. Misallocation and manufacturing TFP in China and India. Quarterly Journal of Economics 124:1403–48.

Oberfield, Ezra, "Productivity and Misallocation During a Crisis: Evidence from the Chilean Crisis of 1982," Review of Economic Dynamics, 16 (2013), 100–119.

Olley, Steven and Ariel Pakes. 1996. The Dynamics of Productivity in the Telecommunications Equipment Industry. Econometrica 64, no. 6: 1263-1310.

Osotimehin, S., and F. Pappadà. 2017. Credit frictions and the cleansing effect of recessions. Economic Journal 127:1153–87.

Petrin, A. and Sivadasan, J. (2013), "Estimating Lost Output from Allocative Inefficiency, with an Application to Chile and Firing Costs", The Review of Economics and Statistics 95(1), pp. 286-301.