NBER WORKING PAPER SERIES

CAPITAL REALLOCATION

Andrea L. Eisfeldt
Yu Shi

Working Paper 25085
http://www.nber.org/papers/w25085

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 2018

We would like to thank Deborah Lucas, Briana Chang, Wei Cui, Joel David, Matthias Kehrig, Huiyu Li, Benjamin Moll, Adriano Rampini and David Zeke for helpful conversations and comments. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

At least one co-author has disclosed a financial relationship of potential relevance for this research. Further information is available online at http://www.nber.org/papers/w25085.ack

Capital Reallocation
Andrea L. Eisfeldt and Yu Shi
NBER Working Paper No. 25085
September 2018
JEL No. E13,E22,E3,E32,E44,G31,G34

ABSTRACT

Capital reallocation is procyclical, despite measured productive reallocative opportunities being acyclical, or even countercyclical. This paper reviews the advances in the literature studying the causes and consequences of capital reallocation (or lack thereof). We provide a comprehensive set of capital reallocation stylized facts for the US, and an illustrative model of capital reallocation in equilibrium. We relate capital reallocation to the broader literatures on business cycles with financial frictions, and on resource misallocation and aggregate productivity. Throughout, we provide directions for future research.

Andrea L. Eisfeldt
UCLA Anderson School of Management
110 Westwood Plaza
Suite C4.10
Los Angeles, CA 90095
and NBER
andrea.eisfeldt@anderson.ucla.edu

Yu Shi
University of California at Los Angeles
yu.shi.1@anderson.ucla.edu

A data appendix is available at http://www.nber.org/data-appendix/w25085

1 Introduction

Capital reallocation is an important part of US corporate investment, representing 28% of total investment by publicly traded US firms. Moreover, capital reallocation is a direct way to reallocate assets from less productive firms to more productive firms. Accordingly, frictions impeding productive capital reallocation can exacerbate misallocation and depress aggregate productivity.

Working definitions of capital reallocation are based on measurement in models or in empirical work. For the purposes of this article, we define capital reallocation as the transfer or sale of capital between productive technologies or firms. In our stylized model, capital reallocation involves the sale of capital, k from one firm or technology, with productivity, a_i and size k_i, to another firm with productivity a_j and size k_j prior to reallocation. In the data, we primarily measure capital reallocation as sales of property plant and equipment (PP&E), or as acquisitions of entire divisions or firms.

The focus of our review is on the role of capital reallocation in US business cycles. We aim to promote research studying the frictions which impede productive reallocation over the business cycle, as well as research into the role of capital reallocation and misallocation in determining fluctuations in aggregate productivity.

Our focus on the role of capital reallocation in US business cycles is motivated by two robust stylized facts, first documented by Eisfeldt and Rampini (2006). First, capital reallocation is strongly and significantly procyclical. The correlation between the cyclical components of corporate capital reallocation and GDP is 0.58 in US data covering public firms from 1972 to the present, and this correlation is significant at the one percent level. Second, the highly procyclical nature of capital reallocation stands in stark contrast to the cyclical properties of the measured benefits to capital reallocation. Measured benefits to capital reallocation are not procyclical in US corporate data. The gains to corporate capital reallocation can be computed using measures of the dispersion in the productivity of capital across firms. The cross-sectional standard deviation of Tobin's q has no significant cyclical correlation with GDP, nor does the standard deviation of growth rates in total factor productivity (TFP) across industries (Solow (1957), Brainard and Tobin (1968)). Furthermore, the standard deviation of capacity utilization rates across industries is significantly countercyclical.

The joint observation that capital reallocation is procyclical, while measures of dispersion in capital productivity across firms appear to be, if anything, countercyclical, lead Eisfeldt and Rampini (2006) to conclude that frictions which inhibit capital's reallocation to its best use are countercyclical. Business cycle frictions which prevent marginal products from being equated over time or in the cross section were termed business cycle wedges by Chari, Kehoe, and McGrattan (2007), and Hsieh and Klenow (2009) use them to explore the effects of misallocation on differences in productivity across countries.

This paper aims to achieve three goals, namely: (1) to review the facts and the empirical literature studying capital reallocation, (2) to relate the study of capital reallocation to modern studies of business cycles with frictions, and (3) to explore the integration of research on capital reallocation with research on misallocation and aggregate TFP. We pursue each goal with the overarching objective of providing fruitful directions for future research.

In Section 2 we review the empirical literature on capital reallocation and productivity dispersion. We also present a comprehensive set of stylized facts describing the cyclical properties of the amount of capital reallocation, the benefits to reallocation as measured by productivity dispersion across firms, and reallocation frictions such as financial or uncertainty shocks. In Section 3 we review the literature on business cycles and capital reallocation with frictions, and provide a simple model of capital reallocation in a static equilibrium model of capital reallocation and production. We illustrate the role of aggregate productivity, productivity dispersion, borrowing constraints, and capital liquidity costs in determining aggregate capital reallocation. In our model, increased productivity alone does not lead to a greater quantity of capital reallocation. Improvements in financial conditions or capital liquidity increase reallocation, and the increase is greater if dispersion in productivity is large. Finally, in Section 4, we integrate the methods and findings from Eisfeldt and Rampini (2006) regarding capital reallocation and capital reallocation frictions with the insights from Hsieh and Klenow (2009) regarding the effects of capital misallocation on aggregate productivity. We argue that the amount of reallocation provides crucial information about capital misallocation, and reallocation frictions, in the US across booms vs. recessions. A measure of misallocation costs which uses both capital reallocation and productivity dispersion data suggests that about half of output losses in recessions are due to the lower rate of capital reallocation from less produtive to more productive firms.

2 Stylized Facts

In this section, we review the stylized facts on capital reallocation and measures of productivity dispersion that, in a simple frictionless model, capture the benefits to capital reallocation. We briefly discuss caveats to these benefits measures. A comparison to labor reallocation is also provided. Finally, motivated by modern studies of business cycles, we discuss the relation betwen measures of capital reallocation, and measures of firm financing and finanical uncertainty.

The empirical literature on capital reallocation has documented two main facts about corporate capital transactions. First, capital reallocation appears to come in waves that coincide with either high aggregate productivity, high equity market valuations, or both. This is true for both piecemeal reallocation through sales of property, plant and equipment (see Eisfeldt and Rampini (2006)), and for mergers of entire firms (see Caballero and Hammour (2001), Jovanovic and Rousseau (2002), Harford (2005), Eisfeldt and Rampini (2006), and Caballero (2007)).[1] Second, capital tends to flow from less productive managers, firms, or divisions to more productive ones (see Maksimovic and Phillips (1998) and Maksimovic and Phillips (2001), Schoar (2002), Giroud and Mueller (2015), David (2011), and Kehrig and Vincent (2017)).

The top panel of Table 1 provides data on turnover rates for sales of PP&E and acquisitions by US public companies. On average, 1.96% of capital is reallocated annually. On average, boom years, defined as years in which GDP is above its HP filtered trend, correspond to a 50% higher reallocation rate. The top panel of Table 1 shows that capital reallocation measured by sales of PP&E and acquisitions by US public companies is highly and statistically significantly correlated with GDP at the cyclical frequency.[2] The point estimate is 0.58 and is significant at the 1% level. Figure 1 plots the cyclical components of reallocation vs. GDP to visually illustrate the procyclical nature of the amount of capital reallocation.

Understanding the drivers of capital reallocation, as well as potential reallocation frictions and resulting capital misallocation, requires an understanding of the benefits to capital reallocation. Dispersion in firm-level productivity has been used to measure opportunities for productive corporate reallocation. However, we note that the extent to which measured productivity dispersion represents reallocation opportunities is an interesting and open question. The answer depends on the technologies (homogenous capital vs. putty-clay, as in Johansen (1959)), on the risk characteristics of firms (see David, Schmid, and Zeke (2018) for the effect of risk-pricing on estimates of the marginal product of capital), and on whether dispersion proxies for firm-level uncertainty or productivity differences (see Bloom (2009)).

The business cycle properties of productivity dispersion, interpreted as opportunities for productive reallocation, have been documented in two main studies. Eisfeldt and Rampini (2006) show that dispersion in firm-level Tobin's q and dispersion in firm-level investment rates have no statistically significant cyclical correlation with GDP.[3] They also show that dis-

[1]See Ottonello (2017) for the related finding that more structures are vacant following negative financial shocks.

[2]The Appendix contains the data description. Table 1 provides an update to Tables 1 and 3 in Eisfeldt and Rampini (2006). The results, using sixteen additional years of data, are remarkably similar to the results in that paper.

[3]Jovanovic and Rousseau (2002), argues that dispersion in q drives merger waves. Using Compustat

persion in industry-level TFP growth rates and capacity utilization rates are countercyclical. Eisfeldt and Rampini (2006) used Compustat data, along with industry level data. A very important, and more recent, contribution to the measurement of productivity dispersion over US business cycles using establishment level data is Kehrig (2015). Kehrig (2015) rigorously documents two key facts for the capital reallocation and resource misallocation literatures: First, dispersion in productivity levels across establishments, within industries, is countercyclical. Second, the increase in dispersion in recessions is mainly driven by a higher share of lower productivity establishments. Kehrig's study represents a very important step for understanding the effects of misallocation on aggregate TFP over US business cycles.[4] His evidence shows that, at the establishment level, the apparent benefits to capital reallocation are strongly countercyclical.

Consistent with this prior research, the middle panel of Table 1, and the associated plot in Figure 2, illustrate that simple measures of the benefits to reallocation are not statistically significantly positively correlated with GDP at the cyclical frequency. This fact makes the procyclical nature of capital reallocation puzzling from the perspective of a frictionless neoclassical model. Firm-level dispersion in Tobin's q has no significant cyclical correlation with GDP. The dispersion in TFP growth rates across industries is not significantly cyclical either. Dispersion in capacity utilization across industries is countercyclical.

In addition to studying the relationship between the amount of, and benefits to, capital reallocation and GDP at the cyclical frequency, we also report the direct correlation between the cyclical components of the amount of reallocation, and measures of the dispersion in the marginal product of capital, in the top panel of Table 2. The direct correlations support the conclusions from Table 1. The only significant correlations, between reallocation and industry level dispersion in capacity utilization and between reallocation and firm-level dispersion in pre-reallocation marginal products of capital, are negative.

For comparison, we also report the cyclical properties of labor reallocation up to the present date.[5] A comparison between labor and capital reallocation is interesting because labor and capital are likely subject to different frictions, but both labor and capital should flow from less productive firms to more productive firms to equalize marginal products. As can be seen in Panel C of Table 1, job creation, which is the counterpart to new investment for capital is procyclical. The direct labor counterpart to capital reallocation is excess job

data, they show that merger waves coincide with wider dispersion in firm-level Tobin's q. One caveat is that aggregate valuation waves can lead to very high values of Tobin's q for a subset of firms. Indeed, Eisfeldt and Rampini (2006) show that excluding very large q's (above five), changes the estimated correlation between the cyclical component of GDP and dispersion in q from positive to negative.

[4] See also Kehrig and Vincent (2017).

[5] See Davis and Haltiwanger (1992) and Davis, Haltiwanger, and Schuh (1998).

reallocation, or the minimum of job creation and job destruction. Excess job reallocation has no statistically significant correlation with GDP at the cyclical frequency.

Relative to the literature on labor reallocation, the literature on capital reallocation is less expansive.[6] This is striking, because most studies of the effects of financial frictions focus on constraints which limit the growth of firms' capital stocks. Moreover, capital reallocation appears to be more procyclical than either gross or excess labor reallocation. Part of the imbalance between studies of capital vs. labor reallocation may be because suboptimal allocation of capital can be addressed by new investment as well as capital reallocation. However, capital reallocaction is an important part of investment overall. Reallocation averaged about 28% of total investment for public US firms over our sample, which matches the finding in Eisfeldt and Rampini (2006) using data up to 2000.[7] Reallocation, or the purchase of used capital, can also be a faster way to accumulate capital than new investment. Finally, if different constraints and costs affect the reallocation of existing capital vs. the production of new capital, comparing these two types of investment can be used to identify important business cycle frictions. Finally, Lanteri (2016) presents intriguing new evidence that used capital prices are more volatile and procyclical than prices of new capital.

The bottom panel of Table 2 reports the correlation between the cyclical components of the reallocation measures and financial flows, as well as measures of uncertainty. These financial flow and uncertainty variables are motivated by the literature on business cycles with financial frictions and uncertainty shocks.

Capital reallocation is significantly positively correlated with debt financing, and total financing, in support of theories of capital reallocation in the presence of financial frictions.[8] On the other hand, capital reallocation is not significantly correlated with equity financing.

Uncertainty measures such as the VIX and dispersion in the idiosyncratic component of stock returns do not display a significant correlation with measures of capital reallocation at the cyclical frequency. This may not be surprising, since firm-level uncertainty measures are closely related to the measures of productivity dispersion used to measure the benefits to capital reallocation. The bottom panel of Table 1 shows that these related reallocation benefits measures have little or no cyclical correlation with reallocation. Bloom (2009) shows that uncertainty shocks can generate realistic business cycle dynamics. Recent studies have found that the effect of uncertainty shocks may work through an interaction with financial

[6] See Eisfeldt and Rampini (2006) and Caballero (2007) for comparisons between capital and labor reallocation.

[7] Ramey and Shapiro (1998a) also emphasize that capital reallocation represents a sizable contribution to total US investment.

[8] For the reasons stated in Covas and Den Haan (2011), we focus on the bottom 90% of firms as defined by total asset size. Large firms do not appear financially constrained, and are so large relative to the rest of firms that their behavior can change the cyclical properties of aggregate quantities in Compustat.

frictions.[9]

Most existing studies of business cycles with financial frictions and uncertainty shocks focus on new investment. We explore the role of aggregate productivity shocks, financial constraints, and changes in productivity dispersion in an illustrative equilibrium model of capital *reallocation* in Section 3. The model confirms the empirical plausibility of important interactions between productivity dispersion and financial constraints in explaining capital reallocation dynamics.

3 Capital Reallocation and Business Cycles: Theory

In this section, we review the theoretical literature on capital reallocation over the business cycle, and use a simple model to illustrate promising directions for future research. The literature on capital reallocation over the business cycle is closely related to, and builds on, the more general literature on business cycles with financial and real frictions. Three widely studied mechanisms used in the modern business cycle literature to generate realistic economy wide fluctuations are financial frictions, uncertainty shocks, and physical adjustment costs. We begin by reviewing the related literature, which also includes studies which incorporate realistic over-the-counter (search) models of capital reallocation. We conclude this section by presenting and analyzing a parsimonious model of equilibrium capital reallocation to illustrate the important role of three key frictions in determining capital reallocation, namely financial constraints, uncertainty or productivity dispersion, and technological or specificity costs of reallocation. We use this model to integrate lessons from the literature and to provide directions for future research.

3.1 Reallocation Theory Literature

Several recent papers study capital reallocation and provide explanations for its cyclical properties. Many of these papers build on important recent contributions in the business cycle literature that studies the amplification and propagation of business cycle shocks via frictions affecting new investment. These modern business cycle models feature either financial shocks (see Gertler and Kiyotaki (2010), Khan and Thomas (2013), Jermann and Quadrini (2012)), or shocks to the dispersion of individual firm-level productivities, (see Bloom (2009)), or both financial and uncertainty shocks (see Christiano, Motto, and Rostagno (2014), Gilchrist, Sim, and Zakrajšek (2014), Arellano, Bai, and Kehoe (2016), and Alfaro, Bloom, and Lin (2016)).

[9] See Christiano, Motto, and Rostagno (2014), Gilchrist, Sim, and Zakrajšek (2014), Arellano, Bai, and Kehoe (2016), and Alfaro, Bloom, and Lin (2016).

The interaction between financial frictions and capital reallocation has been explored in several recent papers. Herrera, Kolar, and Minetti (2011) provide the stylized facts for credit reallocation, and provide a link between credit reallocation and business cycles. By their measure, the reallocation of credit is highly volatile, but only moderately procyclical. Chen and Song (2013) show that the difference in capital productivities of financially constrained firms vs. unconstrained firms is higher in recessions. Their finding supports the idea that financial constraints play an important role in preventing resources from flowing to the most productive locations in recessions. Exploiting this fact in a quantitative model with TFP news shocks, the authors are able to generate realistic business cycles resulting from reallocation to financially constrained, but highly productive firms following good news about future TFP. In related work, Ai, Li, and Yang (2016) develop an extension of Gertler and Kiyotaki (2010) in which intermediaries' ability to finance productive reallocation declines following negative financial shocks. The resulting decline in reallocation amplifies and propagates the decline in intermediary net worth through the negative effect on productivity and output. The authors show that their model produces more realistic business cycle dynamics when financial shocks are included in addition to traditional TFP shocks. Cui (2017) develops a model of reallocation between incumbent and exiting firms. In that model, shocks which tighten borrowing constraints can actually prevent less productive firms from exiting because the decrease in their leverage increases their option value from remaining active by reducing debt overhang. This effect seems interesting given the emphasis on entry and exit in the larger literature on resource misallocation (see Hopenhayn (2014)).

Microfoundations for capital reallocation frictions include adverse selection, agency costs, and search. Eisfeldt (2004) provides an early model of an endogenous link between adverse selection and aggregate capital productivity. In that model, adverse selection increases in recessions due to lower investment in risky projects, leading to fewer reallocative shocks. Fuchs, Green, and Papanikolaou (2016) combine the effects of delayed asset sales and adverse selection in a model which generates endogenous capital liquidation costs. That paper uses the direct intuition that greater dispersion in productivity can exacerbate adverse selection problems to understand procyclical capital reallocation despite apparently countercyclical reallocation benefits. Li and Whited (2015) also study a model of capital reallocation with adverse selection. Like Cui (2017), they emphasize the role of entry and exit. An interesting feature of their model is that higher moments of the size distribution matter for reallocation dynamics. The joint distribution of productivity and size is also emphasized in Cooper and Schott (2013). It is intuitive that this joint distribution should matter for reallocation dynamics, since both size and productivity determine marginal products.

Eisfeldt and Rampini (2008) motivates countercyclical reallocation frictions with endogenously cyclical agency costs. In their model, managers are more reluctant to downsize in bad times when outside options deteriorate. Their paper also provides an analytical expression for the output loss from misallocation due to managerial agency costs over the business cycle.

Given that the market for used capital, plants, divisions and firms is a decentralized one, incorporating search frictions seems like a very fruitful direction for capital reallocation research.[10] David (2011) develops a search model of mergers and acquisitions which generates aggregate productivity growth through an efficient reallocation of resources. New work by Dong, Wang, and Wen (2017) emphasizes the importance of both financial shocks and search frictions in a quantitative DSGE model that is able to match the stylized facts for capital reallocation, including the higher relative volatility for used vs. new capital prices documented by Lanteri (2016). Moreover, Dong, Wang, and Wen (2017) show that search can explain capital unemployment, as documented by Ottonello (2017).[11] A related paper by Wright, Xiao, and Zhu (2018) develops a model of capital investment and reallocation subject to search, bargaining, and liquidity frictions, with an explicit focus on microfoundations and analytical characterizations. Cao and Shi (2014) also study capital reallocation in an equilibrium search model. They, like Cui (2017), stress the importance of firms' entry and exit decisions. Specifically, Cao and Shi (2014) emphasizes the role of procyclical firm entry in improving capital market liquidity, increasing used capital prices, and encouraging lower productivity firms to sell more capital in booms.

Physical adjustment costs and capital liquidity also play an important role in capital reallocation dynamics. Ramey and Shapiro (1998b) is an early contribution studying capital reallocation in the face of adjustment costs. Eisfeldt and Rampini (2006) argued that physical adjustment costs are unlikely to be countercyclical since opportunity costs of foregone output are actually higher in booms. However, Lanteri (2016) points out that despite the fact that less productive firms may have stronger incentives to downsize after negative aggregate productivity shocks, more productive firms may prefer to allocate their limited investment following such negative shocks to new capital if used capital is an imperfect substitute due to capital specificity. Lanteri's paper thus provides a plausible reconciliation for why the disincentive to grow by purchasing used capital for high productivity firms dominates the incentives to downsize of less productive firms during recessions, dampening capital

[10] Rocheteau and Weill (2011) provide a comprehensive review of the use of search models in understanding asset markets. See also Gavazza (2011).

[11] For related work on frictional markets and labor reallocation dynamics, see Chang (2011) and Zhang (2016). Chang (2011) focuses on the interaction between sectoral shocks and firms' optimal hiring and firing decisions on labor markets' matching efficiency, while Zhang (2016) develops the important interaction between financial leverage and employment and wage decisions by firms in a model which emphasizes the importance of the extensive margin of firm entry and exit on labor reallocation.

reallocation in downturns.[12]

3.2 Model

We develop a one period general equilibrium model of capital reallocation in order to illustrate the role of aggregate productivity, cross sectional dispersion in firm-level productivity, financial constraints, and capital liquidity costs in determining the quantity and value of aggregate capital reallocation. Capital reallocation is driven by exogenously given ex-ante mismatches between firm-level productivity and capital. We begin with a baseline frictionless model, and then we add to this model a collateral constraint, and a technological or specificity cost of selling capital. Without frictions, marginal products of capital are equated across firms post-reallocation. In the models with financial or real trading frictions, the degree of frictions determines the remaining dispersion in marginal products post-reallocation. We study the comparative statics for the amount and value of aggregate capital reallocation, describing how capital reallocation responds to aggregate productivity, to the tightness of the collateral constraint, to the dispersion in firm-level productivities, and to the size of the capital liquidity cost.

In this simple equilibrium model, we illustrate the fact that aggregate productivity shocks alone are unlikely to generate a realistic business cycle correlation for capital reallocation; higher aggregate productivity alone does not lead to greater capital reallocation in either a frictionless model, or a model with financial or real trading frictions. In contrast, relaxing financial constraints increases reallocation. Moreover, reallocation increases by more when constraints are relaxed when aggregate productivity is high. We also confirm the result in Eisfeldt and Rampini (2006), namely that reducing capital liquidity costs increases capital reallocation. If specificity costs are interpreted to include search or adverse selection costs, as in the literature described in Section 3.1, it is possible that these costs are countercyclical. Finally, we also study the effects of changes in productivity dispersion. Productivity dispersion has alternatively been used to measure the benefits to capital reallocation (Eisfeldt and Rampini (2006)) or capital misallocation (Hsieh and Klenow (2009)), and to measure uncertainty shocks (Bloom (2009)). Future work could help to disentangle the different effects of productivity dispersion. In our model, an increase in productivity dispersion counterfactually leads to more reallocation, that is, dispersion measures the benefits to productive reallocation. However, as in the business cycle literature, a higher dispersion in productivity can magnify the effects of changes in either financial constraints or capital liquidity costs in

[12] See also Eisfeldt and Rampini (2007) for a model in which firms choose between new and used capital. In that paper, used capital is preferred by financially constrained firms because it has a lower up front cost, despite higher lifetime maintenance costs.

a way that appears consistent with empirical patterns.

The economy consists of a measure one of firms who are endowed with zero financial wealth and a productive technology to produce final output. Each firm is also endowed with idiosyncratic productivity a_i, and capital k_i, both of which are drawn from uncorrelated Pareto distributions.[13] Each firm i's initial capital is drawn from a Pareto distribution $k_i \sim P(k_m, c)$, where $c > 1$ is the curvature parameter and k_m is the lower bound for capital. The probability density function for capital is $\frac{ck_m^c}{k_i^{c+1}}$. Productivity is independently assigned from a Pareto distribution $a_i \sim P(a_{agg}, f)$. The probability density function for productivity is $\frac{fa_{agg}^f}{a_i^{f+1}}$ where a_{agg} is the lower bound of productivity and f is the curvature parameter. The lower bound a_{agg} captures the aggregate productivity level in the economy.[14] Recall that the higher is the tail decay parameter for the Pareto distribution, the lower is the amount of cross-sectional dispersion. Thus, comparative statics over f can be used to study the effects of increases or decreases in productivity dispersion. A higher f will result in faster decay in the right tail of productivity levels, and thus a lower dispersion in productivity.

Firms have access to technologies to produce final goods according to $a_i\hat{k}_i^{\theta}$, with $0 < \theta < 1$, where, as in Eisfeldt and Rampini (2006), $\hat{k}_i$ denotes capital after capital sales or purchases, i.e. after capital reallocation has taken place. We normalize the price of the final product to be 1. Capital is traded at a marketing clearing price P. Each firm chooses capital sales or purchases to maximize their output according to:

$$\max_{r_i} \; a_i\hat{k}_i^{\theta} - P\, r_i + l_i - l_i(1 + r_l), \tag{1}$$

subject to the law of motion for capital,

$$r_i = \hat{k}_i - k_i, \tag{2}$$

where r_i is positive if the firm is a net buyer of capital, and negative if it is a net seller, and the budget constraint

$$P\, r_i = l_i, \tag{3}$$

where l_i denotes the funds that firms borrow to fund capital purchases. In the baseline model, we assume that firms borrow without constraints at a zero interest rate from an (unmodeled) financial intermediary ($r_l = 0$). We also assume zero discounting from the beginning of the period when reallocation (and loans) are chosen to the end of the period when output is produced and loans are repaid. Firms' optimization problems are unaffected by borrowing

[13] To be precise, we use a Type (I) distribution, for which the two specified parameters are the minimum value, and the tail decay parameter.

[14] The mean of a_i increases in a_{agg}, while the coefficient of variation is invariant to a_{agg}.

and lending in the frictionless model since the funds borrowed and loan repayments will cancel out exactly, and hence we drop the last two terms in Equation (1) and constraint (3) in most of what follows. The market clearing price P ensures that net aggregate reallocation is zero:

$$\sum_i r_i = 0. \tag{4}$$

An equilibrium in this economy requires that all firms optimize according to Equations (1) to (3), and markets clear according to Equation (4). The model can be solved analytically as follows. Firms' first order condition is:

$$\hat{k}_i = (\frac{P}{\theta a_i})^{\frac{1}{\theta-1}}. \tag{5}$$

Equation (5) holds for each firm in the economy, and thus all marginal products of capital are equated to the equilibrium price in the frictionless model. Firms whose initial capital is larger than this optimal amount, i.e. those firms for which $k_i \geq (\frac{P}{\theta a_i})^{\frac{1}{\theta-1}}$, will be sellers, and firms whose initial capital is smaller than this amount will be buyers. Note that we can rewrite the marketing clearing condition in Equation (4) as:

$$\sum_i \hat{k}_i = \sum_i k_i. \tag{6}$$

This condition can be used to find the marketing clearing price of capital.[15] In particular, integrating over firm level capital stocks and productivity levels, the market clearing price of capital must satisfy the following equation:

$$\int_{a_{agg}}^{\infty} \frac{f a_{agg}^f}{a^{f+1}} \int_{k_m}^{\infty} (\frac{P}{\theta a})^{\frac{1}{\theta-1}} \frac{c k_m^c}{k^{c+1}} dk da = \int_{a_{agg}}^{\infty} \frac{f a_{agg}^f}{a^{f+1}} \int_{k_m}^{\infty} k \frac{c k_m^c}{k^{c+1}} dk da. \tag{7}$$

Simplifying, we have the following equation which determines the market clearing price:

$$\frac{f}{f + \frac{1}{\theta-1}} (\frac{P}{\theta a_{agg}})^{\frac{1}{\theta-1}} = \frac{c k_m}{c-1}. \tag{8}$$

After solving for the market clearing price, we can get the aggregate quantity of reallocation R, which is equal to one half of the sum of all capital sales plus all capital purchases:

$$R = \frac{1}{c-1} k_m^c (\frac{P}{\theta a_{agg}})^{\frac{1-c}{\theta-1}} \frac{f}{\frac{1-c}{\theta-1} + f}. \tag{9}$$

[15] We require $f + \frac{1}{\theta-1} > 1$ to ensure that the left hand side of Equation (6) is finite.

This yields the complete model solution.

Figure 3 provides an intuitive picture of the model solution. Fixing one level of firm-level productivity, this graph shows the trading regions for firms of various sizes as a function of the market clearing price of capital. Firms' initial endowment of capital is plotted along the x-axis. The y-axis plots the optimal post-reallocation firm size as a function of firms' initial capital, productivity (which is the same for all firms in the illustrative figure), and the market clearing price. The thin solid line plots the Pareto distribution of firm sizes. Recall that the higher is the decay parameter c, the smaller is the right tail of firm sizes. The horizontal line at $\hat{k}_i = \left(\frac{P}{\theta a}\right)^{\frac{1}{\theta-1}}$ plots firms' optimal post-reallocation capital stocks. Because all firms in the figure have the same level of productivity, they all choose the same post-reallocation size in the frictionless model. The 45-degree line plots capital stocks with zero reallocation. In equilibrium, firms move from the 45-degree line to the horizontal line which denotes optimal capital stocks. Firms to the left of the vertical line at $k_i = \left(\frac{P}{\theta a}\right)^{\frac{1}{\theta-1}}$ have initial capital endowments which are smaller than optimal, so they are net buyers, while firms to the right of this line are net sellers.

With the full solution in hand, we can study how the amount of reallocation changes as aggregate productivity changes. In the data, reallocation is higher when aggregate productivity is higher. However, without frictions, in equilibrium the market clearing price of reallocated capital absorbs all of the effects of changes in aggregate productivity, leaving the quantity of capital reallocated unchanged. To see this, note that market clearing requires that Equation (6) holds. The optimal choice of capital after reallocation in the left hand side of this equation is weakly increasing in $\frac{a_i}{P}$ for each firm, while the right hand side is fixed. Thus, if a_{agg} increases, increasing a_i for all firms by the same amount, then P must increase by this same amount so that the equation still holds, leaving reallocation unchanged.

Formally, we can compute comparative statics for the market clearing price of capital using Equation (8) and for the amount of reallocation using Equation (9). We present the comparative static results for the price and quantity of capital reallocation for the baseline model in the first rows of Panels A and B of Table 3, respectively. The Online Appendix contains the analytical details for all comparative statics. Table 3 shows that as aggregate productivity increases, the price of capital increases, while the amount of reallocation is unchanged. Similarly, we can get comparative statics for the capital price and the quantity of reallocation as a function of changes in the dispersion in productivity using the same conditions. We have that, as f increases so that productivity dispersion decreases, that the price of capital falls and the amount of reallocation also declines. The increase in the amount of reallocation as dispersion in productivity increases is intuitive, since productivity dispersion measures the benefits to capital reallocation. Reallocation increases, absent other frictions, when the benefits to reallocation increase. The price effect is due to the fact that f controls the thickness of the right tail of the productivity distribution. The resale price of capital is higher when the right tail is fatter.

Finally, we can compute the cross derivatives between productivity dispersion across firms, and the level of aggregate productivity. Comparative static results for these cross derivatives appear in Table 4. Because aggregate productivity has no effect on the quantity of reallocation in the frictionless model, the cross derivative will also be zero. A higher aggregate shock leads to a smaller increase in the price of capital the lower is the cross sectional dispersion in productivity is. This is intuitive, because, with lower dispersion, the benefits to reallocation are smaller and so is the effect of aggregate productivity on prices. In contrast, given a countercyclical increase in productivity dispersion, the price would fall due to lower aggregate productivity, but the decline would actually be attenuated by the increase in productivity dispersion.

To generate comparative statics in line with the stylized facts describing capital reallocation in Section 2, we augment the baseline model with two frictions motivated by the literature on business cycles and capital reallocation with frictions, namely financial frictions and capital liquidity costs. We model the financial friction as a collateral constraint, such that firms which purchase additional capital can only borrow up to a fraction of the value of their initial capital stock. With the addition of this collateral constraint, firms' optimization problem in Equations (1) to (3) is augmented by the following collateral constraint:

$$Pr_i \leq \xi P k_i, \tag{10}$$

where $\xi \geq 0$ captures the tightness of the collateral constraint.[16] A higher value of ξ corresponds to a more relaxed financial constraint.[17]

The augmented model also nests a capital liquidity cost paid by capital sellers, as in Eisfeldt and Rampini (2006). The liquidity cost captures capital specificity, namely, the fact that when a firm sells capital only that fraction that is generally valuable to all firms receives the market clearing price. With the addition of capital liquidity costs, the law of motion for

[16] Technically, we have that $l_i \leq \xi P k_i$ and $Pr_i = l_i$. However, since we have assumed a zero interest rate for intra-period loans, $l_i - l_i(1 + r_l) = 0$, and the collateral constraint can be applied reallocation itself without loss of generality.

[17] We note that whether firms can leverage only their capital, or also their output matters for the effects on capital reallocation. If firms can borrow against output, then higher productivity firms are less constrained and the equilibrium will feature higher reallocation, which is more sensitive to changes in the constraint tightness (see the Online Appendix for details). A closely related point is made by Li (2015) in the context of the effect of financial constraints on misallocation. That paper shows that misallocation is lower when firms can borrow against output vs. capital only.

capital for each firm given in Equation (2) is replaced by:

$$\hat{k}_i = k_i + r_i - \Gamma(r_i)\mathbb{1}_{r_i<0}, \tag{11}$$

which says the capital stock deployed for production ($\hat{k}_i$) equals the initial capital endowment (k_i) plus the amount of reallocated capital r_i minus the reallocation cost ($\Gamma(r_i)$). The adjustment cost will be zero if firm i is a capital buyer. To aid in analytics, the capital liquidity cost is specified such that all sellers face same marginal reallocation cost, regardless of how much capital they sell: $\Gamma(r_i) = \gamma|r_i|$, where $\gamma \geq 0$ describes how costly it is for firms to sell capital.

The first order conditions for buyers and sellers of capital are, respectively:

$$a_i\theta\hat{k}_i^{\theta-1} + \lambda_i\big(\xi k_i - (\hat{k}_i - k_i)\big) = P, \text{ and,} \tag{12}$$

$$a_i\theta\hat{k}_i^{\theta-1}(1+\gamma) = P, \tag{13}$$

where λ_i is the Lagrangian multiplier on the collateral constraint.

Figure 4 illustrates firms' policy function for $\hat{k}_i$ across size k_i, for a fixed level of firm productivity, a, for the augmented model with a collateral constraint and capital liquidity cost. As can be seen in the figure, the borrowing constraint is linear in initial capital and the parameter ξ. It limits relatively smaller firms because they don't have much collateral to borrow against. The adjustment cost introduces an inaction region for initial capital stocks within which firms don't benefit from trading. The intuition is simple. If there is no inaction region, because sellers lose capital due to the adjustment cost, the marginal sellers would produce with less capital than marginal buyers. This is suboptimal for the marginal sellers and they would rather produce with their full initial capital endowment. Firms with more than the desired capital thus only begin to sell capital once their size implies that the proceeds from selling capital offsets the capital liquidity cost they must pay.

The model with frictions generates equilibrium dispersion in the marginal product of capital across firms. The marginal product of capital for unconstrained buyers will be P, and for capital sellers the marginal product is $\frac{P}{1+\gamma}$. The marginal product of capital for firms in the inaction region lies between these two values. The wedge between marginal products, and the dispersion in marginal products of capital post-reallocation, increases with the magnitude of the capital liquidity cost γ, as in Eisfeldt and Rampini (2006). Finally, financially constrained firms have marginal products of capital higher than P, and the wedge depends on the tightness of the collateral constraint. As a result, dispersion in the marginal product of capital is also increasing in the tightness of the financial constraint.

As in the baseline model, the model with frictions is solved by first finding the optimal capital level for each firm for a given price of capital, then aggregating the demand and supply of capital, and finally solving for the equilibrium capital price which equates supply and demand and yields the equilibrium quantity of capital reallocation. We provide detailed solutions in the Appendix, along with formal comparative statics. We summarize the first order comparative statics in Table 3 for the baseline model, as well as for the augmented models with frictions. For exposition purposes, we nest each case of the augmented model as a separate case, turning only one friction on at a time. Panel A in Table 3 describes the response of the price of capital in each model to changes in parameters that are "improvements" to the economy, namely an increase in aggregate productivity, a reduction in productivity dispersion, a relaxation of the collateral constraint, and a reduction in the capital liquidity cost. Panel B of Table 3 describes the response of the quantity of capital reallocation in each model for these same parameter changes.

The aggregate productivity column of Table 3 shows that, for each model case, the market clearing price of capital is increasing in aggregate productivity, while, if all other parameters are held constant, the quantity of reallocation will remain unchanged. The intuition, arising from the market clearing condition, is the same for the augmented model as for the frictionless model. Again, the first order conditions for all model cases imply that the optimal choices of $\hat{k}_i$ are weakly increasing in $\frac{a_i}{P}$ for all firms. Thus, in order to clear the market in Equation (6), the level change in productivity must be absorbed by an increase in the capital price.

The productivity dispersion column of Table 3 shows that, for all model cases, a reduction in productivity dispersion leads to a lower capital price and less reallocation. When there is less cross-sectional dispersion in productivity (higher f), the demand for reallocation is lower, and both the price of capital and the quantity of reallocation decrease.

The financial constraint column of Table 3 shows that both the price and quantity of reallocation increase when financial constraints are relaxed. As seen in the liquidity cost column of Table 3, the result is slightly different when the capital liquidity cost is reduced; the amount of reallocation increases but the price of capital actually declines. Thus, reducing either of the two capital trading frictions increases the amount of reallocation, but whether the price increases or decreases appears to depend on whether the trading "cost" is paid by buyers vs. sellers. Intuitively, if we relax the constraint on buyers, there will be more demand for capital, which will push the price up. The result is the opposite if the cost is paid by sellers. Relaxing sellers' reallocation cost will result in a greater supply of capital, and thus a lower capital price. Thus, the model illustrates the importance of the specific form of trading frictions for the results in models in which both buyers and sellers can face costs or constraints.

Finally, we present results for the cross effects between the aggregate productivity level, the dispersion in firm-level productivity, and the level of trading frictions. Recent theories of business cycles have emphasized the interaction between aggregate productivity and financial frictions, and between financial frictions and cross section dispersion in firm-level productivities (uncertainty shocks). Table 4 displays the cross comparative static results.

The aggregate productivity columns of Table 4 presents the cross comparative statics for aggregate productivity and the parameters describing cross section productivity dispersion, financial constraints, and capital liquidity. The sensitivity of the equilibrium price of capital increases by less for a given increase in aggregate productivity the lower the cross-sectional dispersion in productivity is. This result holds for all models. With lower productivity dispersion, the benefits to reallocation are smaller and so is the effect of aggregate productivity on prices. On the other hand, the price of capital increases more when either financial constraints are relaxed, or capital liquidity costs are reduced, when aggregate productivity is high. There appears to be a positive multiplier on the price of capital from relaxing trading frictions when aggregate productivity is high.[18] As expected, the level of the aggregate productivity shock has no impact on the comparative statics for the quantity of reallocation in the aggregate productivity columns of Table 4. This is a direct consequence of the zero first derivative effect of aggregate productivity on the quantity of reallocation.

The productivity dispersion columns of Table 4 displays the cross comparative statics for the cross section dispersion in firm-level productivity, and trading frictions. For both the price of capital, and the quantity of capital reallocation, the effect of relaxing frictions is smaller when the cross section dispersion in productivities is smaller. This means that if the cross section dispersion in productivities is larger (a high uncertainty "shock"), then the effect of relaxing frictions will be larger. Loosening the financial constraint by a given amount will lead to a larger increase in reallocation and the price of capital when the dispersion in productivity is higher. Similarly, a given reduction in the capital liquidity cost will increase the quantity and price of reallocated capital by more when the cross section dispersion in productivity is higher. These findings are consistent with recent work that emphasizes the important interactions between dispersion in the cross section and financial or real frictions, such as in the models of Christiano, Motto, and Rostagno (2014), Gilchrist, Sim, and Zakrajšek (2014), Arellano, Bai, and Kehoe (2016), and Alfaro, Bloom, and Lin (2016).

The stylized capital reallocation model illustrates how adding financial frictions, or capital adjustment costs, can help to generate realistic patterns of capital reallocation. These frictions also change the effects of aggregate productivity shocks and uncertainty shocks,

[18]See Lanteri (2016) for related empirical results.

bringing the effects of those fundamental shocks more in line with the data. However, the model is very stylized. The output price is fixed at one, whereas in a fully general equilibrium model, the output price would be pinned down by market clearing and consumers' utility functions. We illustrated the role of capital illiquidity, or specificity costs, on capital sellers, while in practice buyers face installation costs as well. Another caveat is that, while the results for the quantity of reallocation appear to be robust, the results for how the price of capital changes with productivity dispersion depend on the shape of the productivity distribution. Our model features a Pareto productivity distribution, which provides analytical tractability, and features a fat right tail similar to that of a lognormal distribution. Many models feature lognormal productivity distributions, and Pareto distributions have been shown to fit firm size distributions. However, Kehrig (2015) documents a fat *left* tail in the productivity distribution during downturns. Using a mixture of uniform distributions, it is easy to show that an increase in dispersion in a fat left-tailed distribution leads to more reallocation, but at a lower price. Empirically, both the value and quantity of reallocation are proycyclical, so an increase in the thickness of the left tail of productivity in downturns cannot explain procyclical reallocation without other frictions. However, it seems important for future models of heterogeneous firms to incorporate the empirical findings of Kehrig (2015) regarding productivity distribution dynamics.

4 Reallocation, Misallocation, and Aggregate TFP

The study of capital reallocation, and the frictions which inhibit productivity increasing reallocation, is closely related to the important research measuring the effects of resource misallocation on aggregate TFP. Aggregate TFP is determined as a function of the joint distribution of firm-level TFP and firm size. Capital reallocation can increase aggregate TFP by increasing the efficiency of this joint distribution, i.e. by allocating more capital to more productive locations. The idea that capital reallocation can contribute to aggregate TFP fluctuations is suggested by the two main stylized facts from the literature on capital reallocation, namely that capital tends to flow from less productive managers or firms, to more productive ones, and that capital reallocation comes in waves that coincide with high aggregate productivity.

In this section, we review the developing literature on business cycles and aggregate TFP fluctuations due to capital reallocation frictions and capital misallocation. For comparison, we briefly review extensive growth literature on the effects of misallocation on aggregate TFP. To motivate future work on the role of misallocation in US business cycles, we construct annual estimates of output losses from capital misallocation in recessions in two ways. The first method follows Eisfeldt and Rampini (2006), using data on both dispersion in firms' marginal products, and data on capital reallocation. The second method follows Hsieh and Klenow (2009), using only dispersion in firms' marginal products.

4.1 Literatures: Business Cycles and Growth

Early business cycle studies were conducted in a representative agent framework, however modern studies feature heterogeneous firms. Models with heterogeneous firms either explicitly or implicitly feature the effect of shocks and frictions on resource allocation in the cross section. However, as emphasized by Restuccia and Rogerson (2013) in their review of the misallocation literature, little is known about the relative fraction of business cycle fluctuations in aggregate TFP that can be attributed to time series variation in the efficiency of capital allocations in the cross section.

An early contribution studying the effect of misallocation on business cycle dynamics is Caballero and Hammour (1998), which shows how rent appropriation can lead to labor misallocation and sharp recessions. Gavazza (2011) studies real asset liquidity and shows that when real asset markets are thin, firms' average productivity and capacity utilizations are lower while dispersion in productivities and utilization rates are higher. Sraer and Thesmar (2017) show how to scale up estimates from carefully identified micro-econometric studies of the distortive effects of frictions on firm-level decisions to the macro economy.

Several papers focus on the role of financial frictions in generating capital misallocation in US data. Khan and Thomas (2013) develops a model in which credit shocks affecting firms' collateral constraints can lead to persistent recessions through greater capital misallocation in a model in which reallocation of capital occurs through new investment (see also the related work by Chen and Song (2013)). Ai, Li, and Yang (2016) explicitly focuses on the role of capital reallocation in driving variation in capital misallocation over the business cycle in their study of financial intermediation and capital reallocation. Buera and Moll (2015) show that what type of wedge collateral constraints generate (efficiency, investment, or labor) depends crucially on whether firms differ in terms of final goods productivity, investment costs, or recruitment costs. This is important because Chari, Kehoe, and McGrattan (2007) argue that investment wedges play a small role in business cycle fluctuations, a finding that has been interpreted as evidence against an important role for financial frictions. More recently, Kurtzman and Zeke (2017) describe the effects of misallocation due to the Federal Reserve Bank's unconventional monetary policy changing financing costs in heterogeneous way. Finally, Gilchrist, Sim, and Zakrajšek (2013) constructs a misallocation measure based on the observed dispersion in borrowing costs in the US manufacturing sector.[19]

[19]See also Cui and Radde (2016) for a model of financial misallocation. Whited and Zhao (2016) measure

Given the much larger size of the growth literature studying the effects of misallocation on TFP, it is useful to review that literature with a focus on lessons for understanding the role of misallocation in business cycle variation in TFP. An important recent literature in growth economics following Hsieh and Klenow (2009) argues that differences across countries in TFP can be largely accounted for by misallocation of capital in the cross section.[20] Recent reviews of this literature appear in Hopenhayn (2014), which emphasizes the role of selection, entry and exit on aggregate TFP, and provides a benchmark framework for analytical aggregation, and Buera, Kaboski, and Shin (2015), which emphasizes the interaction between selection and financial constraints on long-run growth outcomes.

The growth literature suggests that two main frictions can lead to substantial misallocation, namely, financial frictions and technological adjustment costs. Key contributions to the role of financial frictions in long run resource misallocation include quantitative theoretical studies (Buera and Shin (2013), Hopenhayn (2014)), and empirical studies (Midrigan and Xu (2014), Gopinath, Kalemli-Özcan, Karabarbounis, and Villegas-Sanchez (Forthcoming), Li (2015)). However, two papers question the role of financial frictions in long run misallocation (Moll (2014), Hopenhayn (2014)). Moll (2014) shows that, in a long run steady state, self-financing can undo the effects of financial frictions on investment when differences in productivity are very persistent. On the other hand, financial frictions have large effects on allocations in transitions across steady states, by making transitions sluggish. Thus, Moll's study leaves the door open for financial constraints play a larger role in business cycles. Other recent studies emphasize technological adjustment costs over financial frictions. Prominent contributions include the empirical contributions by Asker, Collard-Wexler, and De Loecker (2014) and Bachmann and Bayer (2014), and the theoretical contribution by Eberly and Wang (2009). Recent work integrates the role of technological, informational, and policy frictions (David, Hopenhayn, and Venkateswaran (2016), David and Venkateswaran (2017)).

In summary, the growth literature has identified important contributions to misallocation from policy distortions, from financial frictions, and from technological adjustment costs. The business cycle literature has made progress in incorporating these frictions into theoretical business cycle studies, however more progress is needed on measuring the quantitative contribution of misallocation. To stimulate future research in this direction, we provide two estimates of the output loss from misallocation over US business cycles in Section 4.2.

misallocation in India and China vs. the US using differences in debt to equity ratios within industries.

[20]Other key contributions documenting the effects of misallocation on TFP across countries include the following studies: Hopenhayn and Rogerson (1993) provide an early investigation of TFP losses from labor policy reallocation frictions. Restuccia and Rogerson (2008) provide a calibrated model of TFP losses from resource misallocation from distortive policies, and emphasize the importance of the joint distribution of distortions and productivity. Hsieh and Klenow (2014) show that older plants survive longer and are less productive in China and India, driving aggregate TFP lower relative to the US.

4.2 Misallocation and Reallocation: Measurement

Hsieh and Klenow (2009) measure misallocation using cross section dispersion in the marginal revenue product of capital.[21] Cross section dispersion in marginal revenue products is a very intuitive measure of misallocation, since, without reallocation frictions, marginal revenue products should be equated. In the context of business cycles, however, measures of productivity dispersion are very noisy, and do not seem to exhibit strong business cycle correlations. As a result, we argue that incorporating data on capital reallocation, for which the cyclical properties are precisely measured, is useful. Although our simple exercise is only illustrative, an analogy can be made to more formal estimation techniques for over-identified systems in which incorporating additional, more precisely measured moments, leads to more efficient estimation.

To illustrate the additional information in the amount of capital reallocation for understanding capital misallocation in the US time series, we conduct two measurement exercises. The first is based on Eisfeldt and Rampini (2006). The basic idea is to compute what the output gain would be if the amount of capital reallocation observed in booms could be achieved in recessions. We find that bout half of output losses in recessions are due to the lower rate of capital reallocation from less produtive to more productive firms in downturns. The remaining difference is explained by higher aggregate productivity, and because, even before reallocation, the joint distribution of firm productivity and size is more efficient in booms.

To compute the loss of output in recessions from misallocation due to depressed capital reallocation, we first construct the firm-level distribution of pre-reallocation marginal products of capital, $mpk_{pre,i}$, for Compustat manufacturing firms each year from 1985 to 2015 following the procedure for estimating Solow (1957) residuals from a log-linear Cobb and Douglas (1928) production function detailed in the Appendix. We do this because we only observe the sellers of property, plant, and equipment, and the buyers in acquisitions. Thus, when computing hypothetical manufacturing output in recession years, we assume that capital is reallocated perfectly efficiently from the lowest to the highest marginal product firms.[22] Then, starting from the distribution of pre-reallocation marginal products of capital, we reallocate capital in each recession year subject to two different constraints. The first, tighter, constraint restricts the total reallocation rate to be equal to the observed reallocation rate in that year. The second, looser constraint allows reallocation to reach the average turnover

[21] Foster, Haltiwanger, and Syverson (2008) are the first to note the important distinction between TFP measured in quantity vs. price terms.

[22] For evidence that capital reallocation flows from less productive firms to more productive firms, see Maksimovic and Phillips (1998) and Maksimovic and Phillips (2001), Schoar (2002), Giroud and Mueller (2015), David (2011), and Kehrig and Vincent (2017).

rate observed in *boom* years. Since reallocation is higher on average in boom years, comparing output under these two constraints yields an estimate of how much higher output in recessions could be if the observed higher, boom-level capital reallocation could be achieved in recession years.

Specifically, each year, and under each of the two constraints, we remove capital from the lowest marginal product firms and allocate it to the highest marginal product firms until the appropriate constraint on capital reallocation is binding. That is, we begin by allocating capital to the highest marginal product firm until its marginal product is equalized to the second highest marginal product firm. We then allocate capital to both firms until their marginal products are equalized to the third highest marginal product firm. We continue until the constraint on capital reallocation is binding. We do the same thing for capital sellers. After the reallocation constraint binds, the marginal product of all capital purchasers will be equated, the marginal product of all sellers of capital will be equated to a lower value, and those firms that neither buy nor sell will have a marginal product of capital which lies between that of buyers and sellers. After reallocation, the ratio between marginal products of buyers (b) and sellers (s) is given by:

$$1 + \tau_t = \frac{mpk_b}{mpk_s} \tag{14}$$

where τ_t can be interpreted, for example, as an unfairly high interest rate on purchased capital as in Chari, Kehoe, and McGrattan (2007). The more reallocation is allowed, the lower the implied wedge will be. Note that this wedge is very similar to the illiquidity cost in Eisfeldt and Rampini (2006), however, unlike in that model, here there is no iceberg (lost capital) cost to capital reallocation.[23]

Finally, we measure the potential output gain in recessions as the average gain over all recession years from increasing reallocation to the average boom turnover rate. We compute

$$\frac{E[Y(R_{\text{boom}})|_{\text{GDP} < \text{trend}}]}{E[Y(R_{\text{rec}})|_{\text{GDP} < \text{trend}}]} - 1, \tag{15}$$

where $Y(R_{\text{boom}})$ and $Y(R_{\text{rec}})$ indicate that firm-level output is computed using post-reallocation capital under the boom and recession reallocation constraints respectively, and aggregate output is the sum over all firms' Cobb Douglas production functions. This calculation yields a potential manufacturing output gain in recession years of 9.08%. Of course, our assumption of efficient reallocation implies that this is an upper bound on misallocation losses in recessions relative to booms. Thus, to put the potential output gain from higher capital

[23] See Samuelson (1954) for a model with iceberg costs of trade in goods.

reallocation in perspective using an apples to apples comparison, we also compute output in both booms and recessions assuming efficient reallocation. We have

$$\frac{E[Y(R_{\text{boom}})|_{\text{GDP > trend}}]}{E[Y(R_{\text{rec}})|_{\text{GDP < trend}}]} - 1 = 17.01\%. \qquad (16)$$

Relative to the gain computed using Equation (15), this gain includes the potential effects of both higher reallocation in booms, and the effect from a higher mean productivity and a possibly more efficient ex-ante joint distribution of firm productivity and capital in booms. Comparing the 9.08% gain from higher reallocation alone to the full 17.01% difference in efficient-reallocation output indicates that about *half* of the output difference comes soley from the higher amount of reallocation in booms.

For comparison, we apply the method in Hsieh and Klenow (2009) to data on US public manufacturing firms over the business cycle. We refer readers to that paper for all estimation equations. We compute the efficiency loss from misallocation at each date using Equation (15) in Hsieh and Klenow (2009) and the associated Online Errata.[24] The efficiency loss from misallocation is the ratio between the hypothetical output generated if all firms were able to equalize their marginal products of capital (Y_{eff}), and actual output (Y), or $Y_{\text{eff}}/Y - 1$. Thus, this misallocation measure is a transformation of the dispersion in firms' marginal products.

On average, for US publicly traded manufacturing firms, we find that the estimated average efficiency gain is 21.24%, which is close to, but slightly smaller than, the estimate using US Census data reported in Hsieh and Klenow (2009). The average efficiency gain in boom years is 21.34% and in recession years it is 21.14%. The efficiency gain time series has no significant cyclical correlation with GDP. These results seem to imply that misallocation does not contribute significantly to output losses in recessions. However, this finding is unsurprising, given that the dispersion measures discussed in Section 2 are closely related to the efficiency gain measure, and those measures also display no significant correlation with GDP at the cyclical frequency. More precise measurement of TFP dispersion, as in Kehrig (2015), which finds countercyclical TFP dispersion using Census data, may help to uncover the true loss from misallocation using this method.

In summary, we argue that incorporating flow data on capital reallocation can help to measure misallocation frictions. Quantity data on flows is model-free, and the amount of reallocation is likely indicative of the cost. Reallocation may also be more precisely measured than marginal products of capital. On the other hand, more work needs to be done to incorporate reallocation data into measures of the aggregate misallocation loss in TFP that can be computed analytically, or that do not rely on the assumption that all reallocation is

[24]See `http://klenow.com/MMTFPAppendix.pdf`

efficient.

5 Conclusion

Capital reallocation represents 28% of total investment, and about 2% of firms total assets are reallocated annually. Reallocation of corporate capital varies substantially over the business cycle, with about 50% more reallocation taking place in booms vs. recessions. Capital reallocation is highly procyclical despite the fact that simple measures of the benefits to capital reallocation do not display significant business cycle correlations.

Some progress has been made in understanding the drivers of capital reallocation over the business cycle, and the frictions which appear to inhibit reallocation in downturns. Explanations include financial frictions, adverse selection, search and technological constraints. In a simple static equilibrium model of capital reallocation, we show that financial frictions and capital liquidity costs are useful in generating variation in capital reallocation. Our model also shows that the effects of both of these reallocation frictions are amplified when productivity dispersion is higher. In this model, greater productivity dispersion robustly increases the quantity of reallocation, however the effect on the price of used capital depends on whether the right or left tail of the distribution drives dispersion. Similarly, whether buyers or sellers pay the costs of reallocation determines whether relaxed constraints or lower costs lead to higher prices, or lower prices. Future work can help to disentangle what changes in reallocation frictions and productivity dispersion are most consistent with empirical observations.

Finally, we explore the implications of lower capital reallocation in recessions for capital misallocation and associated output losses. A measure incorporating both dispersion in firms' marginal products of capital, and the amount of reallocation in booms and recessions, suggests that the greater misallocation of capital in recessions due to lower capital reallocation can lead to average output losses in recessions of 8%.

References

Hengjie Ai, Kai Li, and Fang Yang. Financial intermediation and capital reallocation. *Working Paper*, 2016.

Ivan Alfaro, Nicholas Bloom, and Xiaoji Lin. The finance-uncertainty multiplier. *Working Paper*, 2016.

Cristina Arellano, Yan Bai, and Patrick J Kehoe. Financial frictions and fluctuations in volatility. *Working Paper*, 2016.

John Asker, Allan Collard-Wexler, and Jan De Loecker. Dynamic inputs and resource (mis) allocation. *Journal of Political Economy*, 122(5):1013–1063, 2014.

Rüdiger Bachmann and Christian Bayer. Investment dispersion and the business cycle. *American Economic Review*, 104(4):1392–1416, April 2014.

Nicholas Bloom. The impact of uncertainty shocks. *Econometrica*, 77(3):623–685, 2009.

William C. Brainard and James Tobin. Pitfalls in financial model building. *The American Economic Review*, 58(2):99–122, 1968.

Francisco J. Buera and Benjamin Moll. Aggregate implications of a credit crunch. *American Economic Journal: Macroeconomics*, 7(3):1–42, 2015.

Francisco J. Buera and Yongseok Shin. Financial frictions and the persistence of history: A quantitative exploration. *Journal of Political Economy*, 121(2):221–272, 2013.

Francisco J. Buera, Joseph P. Kaboski, and Yongseok Shin. Entrepreneurship and financial frictions: A macrodevelopment perspective. *Annnual Review of Economics*, 7(1):409–436, 2015.

Ricardo Caballero and Mohamad Hammour. Institutions, restructuring and macroeconomic performance. In *IEA Conference Volume Series*, volume 133, pages 171–193. Springer, 2001.

Ricardo J Caballero. *Specificity and the Macroeconomics of Restructuring*. MIT Press, 2007.

Ricardo J. Caballero and Mohamad L. Hammour. The macroeconomics of specificity. *Journal of political Economy*, 106(4):724–767, 1998.

Melanie Cao and Shouyong Shi. Endogenously procyclical liquidity, capital reallocation, and q. *Working Paper*, 2014.

Briana Chang. A search theory of sectoral reallocation. 2011.

Varadarajan V. Chari, Patrick J. Kehoe, and Ellen R. McGrattan. Business cycle accounting. *Econometrica*, 75(3):781–836, 2007.

Kaiji Chen and Zheng Song. Financial frictions on capital allocation: A transmission mechanism of tfp fluctuations. *Journal of Monetary Economics*, 60(6):683–703, 2013.

Lawrence J. Christiano, Roberto Motto, and Massimo Rostagno. Risk shocks. *The American Economic Review*, 104(1):27–65, 2014.

Charles W. Cobb and Paul H. Douglas. A theory of production. *American Economic Review*, 1928.

Russell W. Cooper and Immo Schott. Capital reallocation and aggregate productivity. *Working Paper*, 2013.

Francisco Covas and Wouter J. Den Haan. The cyclical behavior of debt and equity finance. *American Economic Review*, 101(2):877–99, April 2011.

Wei Cui. Macroeconomic effects of delayed capital liquidation. *Working Paper*, 2017.

Wei Cui and Sören Radde. Money and asset liquidity in frictional capital markets. *American Economic Review*, 106(5):496–502, May 2016.

Joel M. David. The aggregate implications of mergers and acquisitions. *Working Paper*, 2011.

Joel M. David and Venky Venkateswaran. Capital misallocation: Frictions or distortions? *Working Paper*, 2017.

Joel M. David, Hugo A Hopenhayn, and Venky Venkateswaran. Information, misallocation, and aggregate productivity. *The Quarterly Journal of Economics*, 131(2):943–1005, 2016.

Joel M. David, Lukas Schmid, and David Zeke. Risk-adjusted capital allocation and misallocation. *Working Paper*, 2018.

Steven J. Davis and John Haltiwanger. Gross job creation, gross job destruction, and employment reallocation. *The Quarterly Journal of Economics*, 107(3):819–863, 1992.

Steven J. Davis, John C. Haltiwanger, and Scott Schuh. Job creation and destruction. *MIT Press Books*, 1998.

Feng Dong, Pengfei Wang, and Yi Wen. A searched-based framework of capital reallocation. *Working Paper*, 2017.

Janice Eberly and Neng Wang. Capital reallocation and growth. *The American Economic Review*, 99(2):560–566, 2009.

Andrea L. Eisfeldt. Endogenous liquidity in asset markets. *The Journal of Finance*, 59(1): 1–30, 2004.

Andrea L. Eisfeldt and Tyler Muir. Aggregate external financing and savings waves. *Journal of Monetary Economics*, 84:116–133, 2016.

Andrea L. Eisfeldt and Adriano A Rampini. Capital reallocation and liquidity. *Journal of monetary Economics*, 53(3):369–399, 2006.

Andrea L. Eisfeldt and Adriano A Rampini. New or used? investment with credit constraints. *Journal of Monetary Economics*, 54(8):2656–2681, 2007.

Andrea L. Eisfeldt and Adriano A Rampini. Managerial incentives, capital reallocation, and the business cycle. *Journal of Financial Economics*, 87(1):177–199, 2008.

Andrea L. Eisfeldt and Yu Shi. Online appendix to "capital reallocation". *Working Paper*, 2017.

Lucia Foster, John Haltiwanger, and Chad Syverson. Reallocation, firm turnover, and efficiency: Selection on productivity or profitability? *The American Economic Review*, 98 (1):394–425, 2008.

William Fuchs, Brett Green, and Dimitris Papanikolaou. Adverse selection, slow-moving capital, and misallocation. *Journal of Financial Economics*, 120(2):286–308, 2016.

Alessandro Gavazza. The role of trading frictions in real asset markets. *The American Economic Review*, 101(4):1106–1143, 2011.

Mark Gertler and Nobuhiro Kiyotaki. Financial intermediation and credit policy in business cycle analysis. *Handbook of Monetary Economics*, 3(3):547–599, 2010.

Simon Gilchrist, Jae W. Sim, and Egon Zakrajšek. Misallocation and financial market frictions: Some direct evidence from the dispersion in borrowing costs. *Review of Economic Dynamics*, 16(1):159–176, 2013.

Simon Gilchrist, Jae W. Sim, and Egon Zakrajšek. Uncertainty, financial frictions, and investment dynamics. *Working Paper*, 2014.

Xavier Giroud and Holger M. Mueller. Capital and labor reallocation within firms. *The Journal of Finance*, 70(4):1767–1804, 2015.

Gita Gopinath, Şebnem Kalemli-Özcan, Loukas Karabarbounis, and Carolina Villegas-Sanchez. Capital allocation and productivity in south europe. *The Quarterly Journal of Economics*, Forthcoming.

Jarrad Harford. What drives merger waves? *Journal of financial economics*, 77(3):529–560, 2005.

Ana Maria Herrera, Marek Kolar, and Raoul Minetti. Credit reallocation. *Journal of Monetary Economics*, 58(6):551–563, 2011.

Robert J. Hodrick and Edward C. Prescott. Postwar us business cycles: an empirical investigation. *Journal of Money, credit, and Banking*, pages 1–16, 1997.

Hugo Hopenhayn and Richard Rogerson. Job turnover and policy evaluation: A general equilibrium analysis. *Journal of political Economy*, 101(5):915–938, 1993.

Hugo A. Hopenhayn. Firms, misallocation, and aggregate productivity: A review. *Annual Review of Economics*, 6(1):735–770, 2014.

Chang-Tai Hsieh and Peter J. Klenow. Misallocation and manufacturing tfp in china and india. *The Quarterly journal of economics*, 124(4):1403–1448, 2009.

Chang-Tai Hsieh and Peter J. Klenow. The life cycle of plants in india and mexico. *The Quarterly Journal of Economics*, 129(3):1035–1084, 2014.

Urban Jermann and Vincenzo Quadrini. Macroeconomic effects of financial shocks. *The American Economic Review*, 102(1):238–271, 2012.

Leif Johansen. Substitution versus fixed production coefficients in the thoery of economic growth: a synthesis. *Econometrica*, 27:157–176, 1959.

Boyan Jovanovic and Peter L. Rousseau. The q-theory of mergers. *The American Economic Review*, 92(2):198–204, 2002.

Matthias Kehrig. The cyclical nature of the productivity distribution. *Working Paper*, 2015.

Matthias Kehrig and Nicolas Vincent. Do firms mitigate or magnify capital misallocation? evidence from planet-level data. *Working Paper*, 2017.

Aubhik Khan and Julia K. Thomas. Credit shocks and aggregate fluctuations in an economy with production heterogeneity. *Journal of Political Economy*, 121(6):1055–1107, 2013.

Robert J. Kurtzman and David Zeke. Misallocation costs of digging deeper into the central bank toolkit. *Working Paper*, 2017.

Andrea Lanteri. The market for used capital: Endogenous irreversibility and reallocation over the business cycle. *Working Paper*, 2016.

Huiyu Li. Leverage and productivity. *Working Paper*, 2015.

Shaojin Li and Toni M. Whited. Capital reallocation and adverse selection. *Working Paper*, 2015.

Vojislav Maksimovic and Gordon Phillips. Asset efficiency and reallocation decisions of bankrupt firms. *The Journal of Finance*, 53(5):1495–1532, 1998.

Vojislav Maksimovic and Gordon Phillips. The market for corporate assets: Who engages in mergers and asset sales and are there efficiency gains? *The Journal of Finance*, 56(6): 2019–2065, 2001.

Virgiliu Midrigan and Daniel Yi Xu. Finance and misallocation: Evidence from plant-level data. *The American Economic Review*, 104(2):422–58, 2014.

Benjamin Moll. Productivity losses from financial frictions: can self-financing undo capital misallocation? *The American Economic Review*, 104(10):3186–3221, 2014.

Whitney K. Newey and Kenneth D. West. Hypothesis testing with efficient method of moments estimation. *International Economic Review*, pages 777–787, 1987.

Pablo Ottonello. Capital unemployment. *Working Paper*, 2017.

Valerie A. Ramey and Matthew D. Shapiro. Capital churning. *Working Paper, UCSD*, 1998a.

Valerie A. Ramey and Matthew D. Shapiro. Costly capital reallocation and the effects of government spending. *Carnegie Rochester Conference Series on Public Policy*, 48:145–194, 1998b.

Diego Restuccia and Richard Rogerson. Policy distortions and aggregate productivity with heterogeneous establishments. *Review of Economic dynamics*, 11(4):707–720, 2008.

Diego Restuccia and Richard Rogerson. Misallocation and productivity. *Review of Economic Dynamics*, 2013.

Guillaume Rocheteau and Pierre-olivier Weill. Liquidity in frictional asset markets. *Journal of Money, Credit and Banking*, 43(s2):261–282, 2011.

Paul A. Samuelson. The transfer problem and transport costs, ii: Analyisis of effects of trade impediments. *Economic Journal*, 64(254):264–289, June 1954.

Antoinette Schoar. Effects of corporate diversification on productivity. *The Journal of Finance*, 57(6):2379–2403, 2002.

Robert M. Solow. Technical change and the aggregate production function. *The review of Economics and Statistics*, pages 312–320, 1957.

David Sraer and David Thesmar. Aggregating estimates of firm-level capital distortions. *Working Paper*, 2017.

Toni M. Whited and Jake Zhao. The misallocation of finance. *Working Paper*, 2016.

Randall Wright, Sylvia Xiaolin Xiao, and Yu Zhu. Frictional capital reallocation i: Ex ante heterogeneity. *Journal of Economic Dynamics and Control*, 2018.

Lei Zhang. Financial leverage, job reallocation, and firm dynamics over the business cycle. *Working Paper*, 2016.

A. Appendix

Data Description

This section provides a brief description of the data we use in our study. The Online Appendix Eisfeldt and Shi (2017) contains further details, along with a link to data and codes used in this paper. For the Hodrick and Prescott (1997) filter, we use an annual parameter, equal to 100. Annual GDP data is from the FRED database from 1963-2016. Capital reallocation variables and market value weighted Tobin's q are computed using the method in Eisfeldt and Rampini (2006) and Compustat data from 1971-2016 for reallocation, and 1963-2016 for Tobin's q. Capital and reallocation series are deflated using annual CPI data for all urban consumers are from the Bureau of Labor Statistics, and turnover rates use lagged total assets in the denominator. Total investment is the sum of capital realloation and capital expenditures. Annual gross job creation and annual gross job destruction are from Census data for 1977-2015. Excess job reallocation is job reallocation (sum of creation and destruction) minus the absolute value of the net change in employment. See Davis and Haltiwanger (1992). For manufacturing industries, the (output-weighted) standard deviation of total factor productivity growth rates and capacity utilization across industries at the three digit NAICS code level is computed using data from the Bureau of Labor Statistics (for multifactor productivity and the value of sectoral production) and the Federal Reserve Board (for capacity utilization) covering the period 1988-2015. Financing Variables are defined following Eisfeldt and Muir (2016). VIX is the CBOE S&P 500 Volatility Index from 1990-2016. The uncertainty shock estimation follows Gilchrist, Sim, and Zakrajšek (2014) using CRSP data 1971-2016.

A..1 Misallocation Production Function Estimation

We construct annual estimates of firm-level marginal products of capital using firm-level Compustat data on publicly traded manufacturing firms from 1985-2015.[25] We assume that each firm i at time t produces output using capital and labor in a Cobb-Douglas production function:

$$y_{i,t} = a_{i,t} k_{i,t}^{\alpha_i} n_{i,t}^{\beta_i}, \tag{17}$$

where $k_{i,t}$ and $n_{i,t}$ are capital and labor respectively, α_i and β_i are constant firm-level capital and labor shares, and $a_{i,t}$ is the productivity level of the firm. We use sales to measure output, PP&E to measure capital, and employees times wages to measure labor. Because wage coverage is limited in Compustat data, we use six-digit NAICS industry wage data from the Census distributed by the NBER. To study business cycles, we allow firms to have different expected productivities in boom years and recession years, defined by HP filtered GDP relative to trend. We run the following time series regression for each public

[25] Historical NAICS codes, which we use for industry-level wage data, become available in Compustat in 1985.

manufacturing firm to estimate firm-level Solow residuals:

$$\log y_{i,t} = c_i + \psi_i d_t + \alpha_i \log k_{i,t} + \beta_i \log n_{i,t} + \epsilon_{i,t}, \tag{18}$$

where the dummy variable d_t is set to be 1 if t is a boom year, and 0 if t is a recession year, as defined by HP filtered GDP relative to trend.[26] We get TFP for each firm-year by collecting the estimated intercept, dummy and residual terms from the regression in Equation (18).[27]

$$a_{i,t} = \exp(c_i + \psi_i d_t + \epsilon_{i,t}). \tag{19}$$

We then calculate the ex-ante, prior to reallocation, marginal product of capital as:

$$mpk_{pre,i,t} = a_{i,t}\alpha_i k_{i,t-1}^{\alpha_i - 1} n_{i,t}^{\beta_i} \tag{20}$$

where $k_{i,t-1}$ is the beginning of the period, pre-reallocation capital stock of firm i. This procedure yields a panel of marginal products with 19,627 firm-year observations.[28] The median capital share estimate α is 0.32, and the median labor share estimate β is 0.58.

To apply the method in Hsieh and Klenow (2009) to data on US public manufacturing firms over the business cycle requires estimates of capital and labor share parameters. For production function parameter estimates, we use the output weighted $\alpha_s = \sum \frac{Y_i}{Y_s}\alpha_i$ for each 3 digit NAICS manufacturing industry s, where α_i is from the estimate in Equation (18). Labor share is $(1 - \alpha_s)$. As in Hsieh and Klenow (2009) we use industry level wage data (3 digit NAICS industry wage data from the Census, distributed by the NBER) and firm-level data on number of employees to measure the labor input. We measure capital as the average of beginning and end of period PP&E, and we use number of employees to measure the quantity of labor.

Figures

[26]Firms with α_i or β_i less than 0 or greater than 1 are dropped to ensure decreasing returns to scale in capital and labor for production.

[27]In related measurement exercises, Chen and Song (2013) and Ai, Li, and Yang (2016) use the ratio of Operating Income before Depreciation to one-year-lag net Plant, Property and Equipment to measure capital productivity.

[28]To alleviate the effect of outliers, we winsorize $a_{i,t}$ for each year at the 5% and 95% percentiles, and we drop firms with ex-ante marginal products of capital in the top and bottom 1%. We trim, rather than winsorize the marginal products to alleviate the effect of the skewed firm size distribution, which can generate extreme estimates of marginal products for large firms.

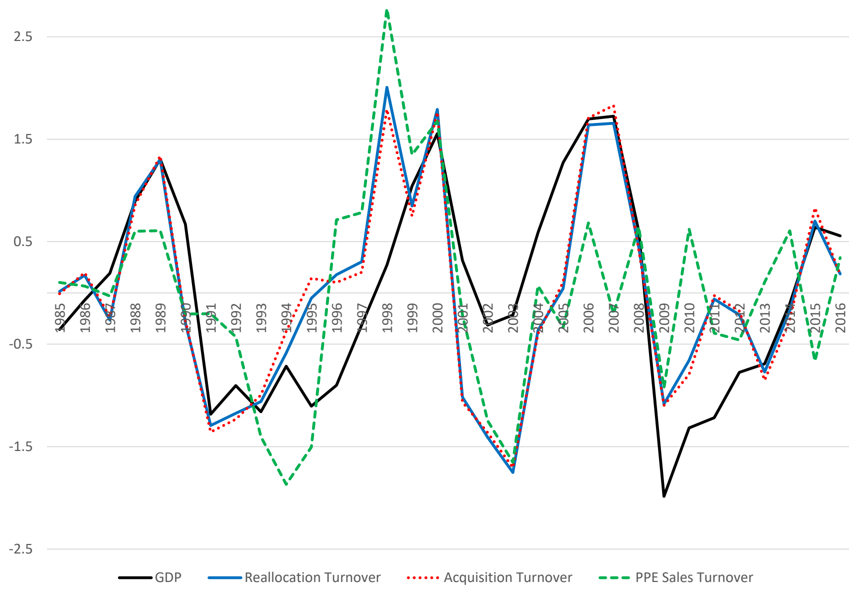

Figure 1: Capital Reallocation Turnover Rates: Capital reallocation is procyclical. This figure plots the cyclical components of the turnover rates for capital reallocation, along with the cyclical component of GDP. Each Series is HP filtered to extract the business cycle component and normalized by the standard deviations of its respective HP filtered series.

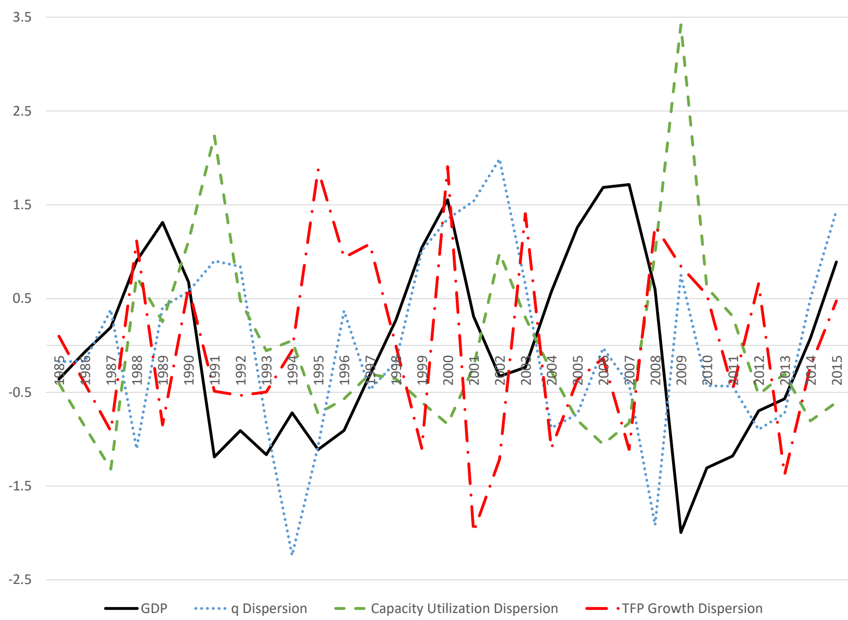

Figure 2: Benefits to Capital Reallocation: Productivity dispersion measures are acyclical. This figure plots the cyclical components of several measures of the benefits to capital reallocation, along with the cyclical component of GDP. Series are HP filtered to extract the business cycle component. Each Series is HP filtered to extract the business cycle component and normalized by the standard deviations of its respective HP filtered series

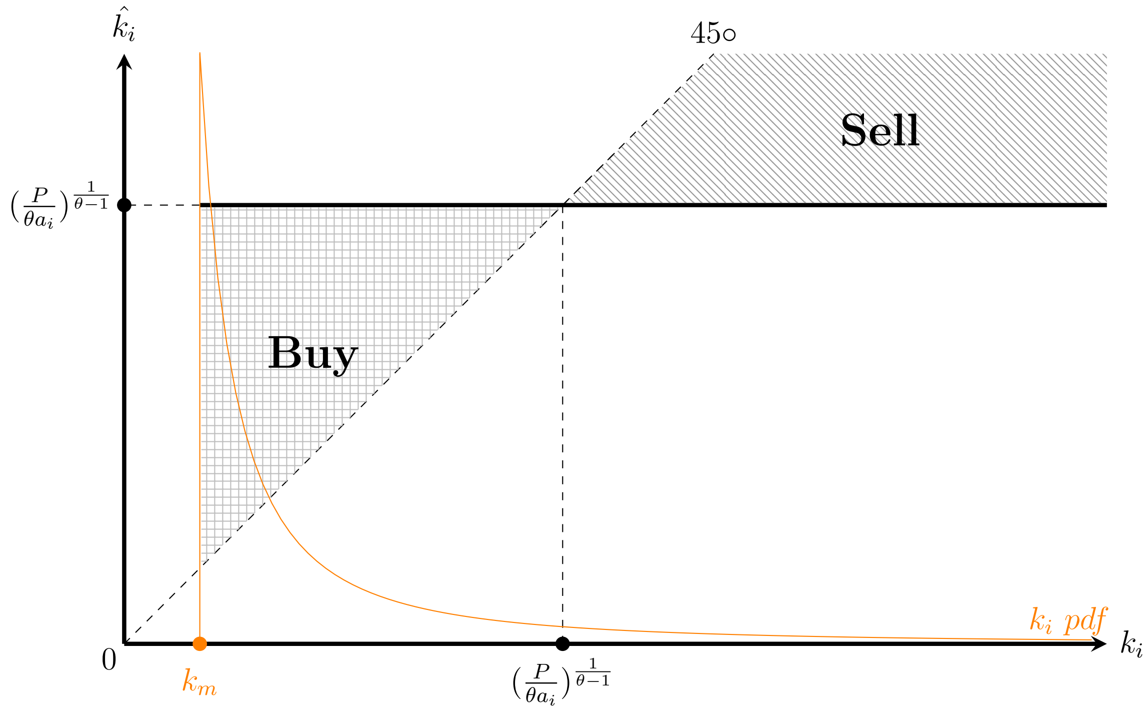

Figure 3: Trading Regions for a Fixed Level of Productivity: Frictionless Model

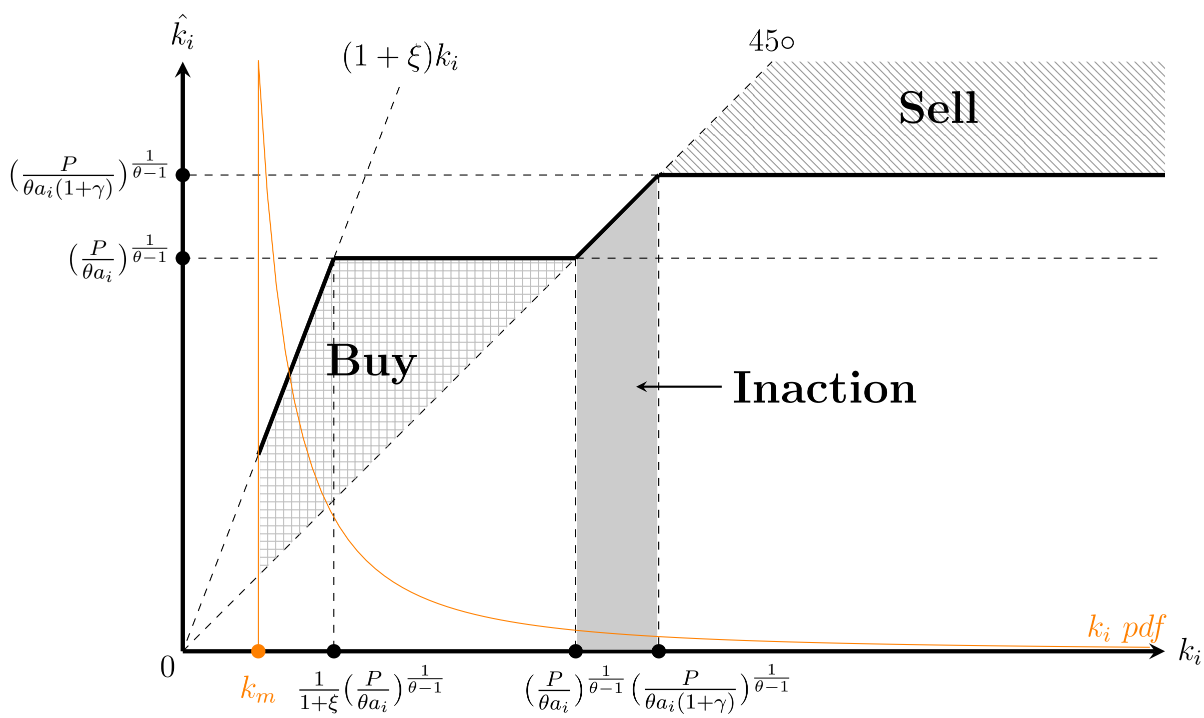

Figure 4: Trading Regions for a Fixed Level of Productivity: Model with Frictions

Tables

Table 1: Cyclical Properties of Reallocation and Productivity Dispersion: Deviations from trend are computed using an annual Hodrick and Prescott (1997) filter. Standard errors are corrected using generalized method of moments, correcting for heteroscedasticity and autocorrelation of the residuals according to Newey and West (1987). Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels. Statistical significance for differences in boom and recession means is indicated next to the reported boom mean. See the Appendix for a detailed data description.

	Correlation with GDP	Unconditional Mean	Boom Mean	Recession Mean
Panel A: Capital Reallocation Turnover Rate				
Total Reallocation Turnover	0.5752***	1.96%	2.30%***	1.61%
	(0.1454)			
Sales of Property, Plant and Equipment Turnover	0.3455*	0.40%	0.43%**	0.36%
	(0.1680)			
Acquisition Turnover	0.5861***	1.56%	1.87%***	1.25%
	(0.1413)			
Panel B: Benefits to Reallocation				
Standard deviation of Tobin's q (firm level, $0 \leq q \leq 5$)	-0.0580	0.77	0.77	0.77
	(0.2250)			
Standard deviation of TFP growth rates (3 digit NAICS level)	-0.1463	3.79	3.56	3.99
	(0.3003)			
Standard deviation of capacity utilization (3 digit NAICS level)	-0.4948***	5.20	4.69	5.64
	(0.1650)			
Panel C: Labor Reallocation				
Job Creation Rate	0.6180***	16.69%	17.65%	15.68%
	(0.1540)			
Job Destruction Rate	-0.3760	14.71%	14.51%	14.93%
	(0.2391)			
Excess Job Reallocation Rate	-0.1030	14.42%	14.51%	14.32%
	(0.3153)			

Table 2: Reallocation vs. Productivity Dispersion and Financial Flows: Deviations from trend are computed using an annual Hodrick and Prescott (1997) filter. (F) denotes firm level, (I) denotes industry level. Standard errors are corrected using GMM, correcting for heteroscedasticity and autocorrelation of the residuals according to Newey and West (1987). Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels. See the Appendix for a detailed data description.

	Total Reallocation Turnover	Sales of PPE Turnover	Acquisition Turnover
Panel A: Correlation with Benefit to Reallocation			
Standard deviation of	-0.0732	0.1464	-0.0922
Tobin's q (F) ($0 \leq q \leq 5$)	(0.2454)	(0.2951)	(0.2363)
Standard deviation of	0.1437	0.0261	0.1488
TFP growth rates (I)	(0.3416)	(0.3047)	(0.3490)
Standard deviation of	-0.5646***	-0.2920	-0.5778***
capacity utilization (I)	(0.1218)	(0.1647)	(0.1207)
Panel B: Correlation with Financial Variables			
Debt Financing	0.6590***	0.4507*	0.6581***
	(0.1530)	(0.2205)	(0.1526)
Equity Financing	-0.1661	0.0766	-0.1876
	(0.4199)	(0.3439)	(0.4180)
Total Financing	0.5261**	0.4768**	0.5122**
	(0.2114)	(0.2029)	(0.2144)
VIX	-0.0691	0.2176	-0.1082
	(0.3377)	(0.2913)	(0.3287)
Uncertainty Shock	0.1744	0.3433	0.1518
	(0.3183)	(0.2194)	(0.3247)

Table 3: Comparative Statics: Capital Price and Quantity of Reallocation

	Aggregate Productivity ($a_{agg} \uparrow$)	Productivity Dispersion ($f \uparrow$, disp. $\downarrow$)	Financial Constraint ($\xi \uparrow$)	Liquidity Cost ($\gamma \downarrow$)
Panel A: Capital Price Sensitivity				
Baseline Model	+	−		
Collateral Constraint	+	−	+	
Liquidity Cost	+	−		−
Panel B: Reallocation Sensitivity				
Baseline Model	0	−		
Collateral Constraint	0	−	+	
Liquidity Cost	0	−		+

Table 4: Cross Comparative Statics: Capital Price and Quantity of Reallocation

	Aggregate Productivity ($a_{agg} \uparrow$)			Productivity Dispersion ($\beta \uparrow$, disp. $\downarrow$)	
Panel A: Capital Price	$\partial P/\partial f$	$\partial P/\partial \xi$	$\partial P/\partial \gamma$	$\partial P/\partial \xi$	$\partial P/\partial \gamma$
Baseline Model	−				
Collateral Constraint	−	+		−	
Liquidity Cost	−		+		−
Panel B: Reallocation	$\partial R/\partial f$	$\partial R/\partial \xi$	$\partial R/\partial \gamma$	$\partial R/\partial \xi$	$\partial R/\partial \gamma$
Baseline Model	0				
Collateral Constraint	0	0		−	
Liquidity Cost	0		0		−