Is Capital Reallocation Really Procyclical?

Lingyan Yang*

October 13, 2021
[Latest Version]

Job Market Paper

ABSTRACT

Aggregate reallocation is procyclical. This empirical observation is puzzling given the documented fact that the benefits to reallocation are countercyclical. I show that this procyclicality is entirely driven by reallocation of bundled capital (e.g. business divisions), which is highly correlated with market valuation and bears no consistent relation to measures of productivity dispersion. Reallocation of unbundled capital (e.g. specific equipment), on the contrary, is countercyclical and highly correlated with dispersion in productivity growth, both within industry and across industries. To rationalize these facts, I propose a heterogeneous agent model of investment featuring two distinct used-capital markets and a sentiment component. In equilibrium, unbundled capital is reallocated for productivity gains only, whereas bundled capital is also reallocated for real, or perceived synergies in the equity market. While equity overvaluation negatively affects total factor productivity (TFP) by encouraging excessive trading of capital, its adverse impact is largely offset by increased liquidity in the unbundled capital market.

JEL classification: E22, E32, E44, G34

*WP Carey School of Business, Arizona State University (email: Lingyan.Yang@asu.edu). I am extremely grateful to my dissertation advisors Sunil Wahal(Co-hair), Oliver Boguth (Co-chair) and Yuri Tserlukevich. For useful comments I also thank Sreedhar Bharath and seminar participants at Arizona State University. Any errors and omissions are my own responsibility.

The empirical literature has documented a positive relation between the aggregate amount of capital reallocated by means of asset sales across firms and total output. This procyclicality is puzzling for many, because the benefits from reallocation (e.g., dispersion in productivity) appear largely countercyclical (e.g., Eisfeldt and Rampini, 2006; Kehrig, 2015). This neoclassical view of reallocation, however, rests on the assumption that capital is a homogeneous factor of production whose productivity adjust instantaneously. If capital instantaneously adapts to the production technology of its new owner, it should flow from less to more productive firms. Greater dispersion in productivity (during economic downturns) thus implies higher potential gains from reallocation, and should spur more reallocation.

In reality, firms reallocate assets in two distinct used-capital markets, one for unbundled capital such as equipment and the other for bundled capital such as standalone business units. While the homogeneous capital assumption may hold reasonably well within unbundled capital, empirical evidence on the reallocation efficiency of bundled capital is at best inconclusive.[1] In addition, the documented features of acquisitions—occurring in waves coinciding with high market valuations—cast further doubts on the motivation behind such reallocation. When we draw inferences on the economic efficiency of reallocation based on certain models, it's important to take into account these differences. Suppose, for example, that unbundled reallocation is productivity enhancing, whereas bundled reallocation is productivity neutral. Then inferences drawn from aggregate reallocation about productivity efficiency can be misleading.

I provide the first disaggregated evidence on the reallocation dynamics of both types of capital and document striking differences in their cyclicalities. This helps to understand why aggregate reallocation is procyclical and what are the economic forces driving reallocation decisions in both markets. I then introduce a dynamic investment model with heterogeneous firms featuring segmented used-capital markets. This would allow to study the economic impact of aggregate reallocation taking into consideration the fundamental differences between these two markets.

A key part of the paper involves the empirical categorization of capital transactions. The commonly employed database Compustat is not sufficient for this task. One of the issues with Compustat is the lack of details as it does not well distinguish between unbundled and bundled

[1] Using Census data for manufacturing industries, Maksimovic and Phillips (2001) recognize that evidence concerning the role of productivity in driving M&As is inconclusive at best. In their paper, M&As overall are followed by productivity losses, albeit insignificant.

capital.[2] In addition, Compustat provides the value of transactions, which is price times quantity, whereas standard economic models are mainly concerned with quantities. This is particularly problematic because resale prices are known to be procyclical (Lanteri, 2018). In this paper, I manually classify capital sales as either bundled or unbundled using information—type of asset sold, value of the sale and corresponding gains or losses—extracted from corporate 10K filings; for each type I then aggregate the transaction values and resale prices.

Using these data, I document striking differences in both the resale prices and reallocation dynamics between the two markets. On average, both capital sell at a premium over book value; however, this premium is much higher for bundled (37.5%) than for unbundled capital (1.5%), suggesting the existence of market segmentation, due to, for example, different participants or different pricing mechanisms. Indeed, the disaggregated evidence suggests that although sellers in the unbundled market are less productive than buyers throughout the cycle, this pattern is typically neutralized or even reversed in the bundled market. In addition, the price of unbundled capital is highly correlated with aggregate output shocks, suggesting a demand/supply-driven market responding to aggregate productivity shocks. The bundled capital price, however, is insensitive to such shocks.

I show that the existing evidence on procyclical reallocation is driven entirely by transactions in the bundled capital market. For the unbundled capital market, the fact that prices are procyclical makes it important to isolate the impact of price when analyzing the cyclicality of reallocation. For this market, I find the value of reallocation to be acyclical; however, once focusing on quantities, reallocation turns countercyclical. In addition, unbundled capital reallocation is highly correlated with dispersion in TFP growth, both within industry and across industries. Thus, in line with neoclassical theory, there really is not a reallocation puzzle so long as we restrict our focus to this more homogeneous type of capital. On the other hand, bundled capital sales are procyclical, highly correlated with sentiment, and bear no consistent relation to productivity dispersion measures.

The evidence suggests that, despite having significant explanatory power, typical neoclassical models are difficult to reconcile with evidence in the bundled market. I propose a dynamic model of investment that can accommodate the additional evidence. Three features distinguish my model

[2]Compustat does provide data on sales of property, plant and equipment, however, it contains a lot of missing values and measurement errors, as I show in the Online Appendix.

from a typical neoclassical model as in Yang (2008). First, I distinguish between two used-capital markets. To liquidate capital, firms can either disassemble the capital and then sell in the unbundled market (with endogenized capital price), or directly post it for sale in the bundled market.[3] Second, I introduce valuation sentiment by assuming that marginal investors irrationally perceive bundled capital deals (e.g., acquisitions) by certain firms as overly beneficial. This "euphoric" sentiment distorts transaction prices when the acquirer uses such a misvaluation strategically. As a result, the bundled capital price varies across transactions depending on the type of the firm involved. In the model, variation in sentiment is captured by the percentage of popular firms in the economy, which is assumed to increase following consecutive good aggregate shocks. This feature allows me to rationalize both the level and dynamic of the bundled capital price in the data. Last, I allow for the possibility of structural changes when firms acquire bundled capital—it may change the acquirer's path of future productivity shocks. This assumption fundamentally distinguishes bundled capital from a homogeneous production factor as unbundled capital.

I show that, without the bundled market, reallocation is driven solely by shocks to productivity. It's optimal for firms to expand when productivity rises, and to downsize when productivity falls. The resale price of capital changes procyclically: it rises as good aggregate shocks improve productivity for all and vice versa. These patterns are similar to predictions from models in Lanteri (2018) and Yang (2008). With a bundled market, firms can now reallocate not only for productivity gains, but also for synergy gains or financial benefits. For instance, as productivity falls, rather than passively waiting, certain firms (with low TFP) may find it beneficial to acquire bundled assets for potential synergy; some may even be able to cash in gains by financing with overvalued equity.

Although the two markets are segmented, reallocation decisions between them are connected: e.g., a relatively cheap cost of acquisition attracts potential buyers with large capital needs into the bundled market. With a price less sensitive to aggregate shocks, the bundled market serves as a "cushion" for reallocation imbalances as certain firms switch to the bundled market when good (adverse) aggregate shocks raise (lower) the unbundled capital price above (below) certain levels.[4] In addition, sentiment fueled reallocation distortions in the bundled market create hidden capital

[3] I assume owned capital is firm specific; however, once disassembled, it becomes a homogeneous factor of production. In the bundled market, deal completion is not guaranteed and occurs with some probability.

[4] The "switchability" is imperfect here: e.g., for investing firms with high productivity, bundled capital is an inferior substitute for unbundled capital because it may cause deterioration in future productivity.

liquidity that gets activated during periods of large price swings: e.g., as the unbundled capital price rises, firms previously overinvested in bundled capital become less willing to wait for an uncertain bundled disposition (despite attractive pricing) and more likely to sell unbundled, which in term lowers the unbundled capital price. These cross-market interactions attenuate the response of the unbundled capital price to aggregate shocks, facilitating efficient reallocation.[5]

Valuation sentiment in such an economy has two offsetting effects on aggregate productivity. On the one hand, it spurs excessive opportunistic trading in the bundled market featuring active overinvestment and divestment. These transactions are typically counterproductive—e.g., when synergy fails to materialize and firms get stuck with unproductive capital for too long. On the other hand, the high valuation also serves as a lubricant, easing reallocation frictions in both markets. In the model, I show that the net impact relies crucially on the extent to which equity value distortion gets incorporated into to real asset prices.

I calibrate the model to match key moments on the level and dynamics of both resale prices and reallocation quantities in both markets. The model helps explain who buys or sells capital, the corresponding reallocation efficiency, and the reallocation dynamics in both markets. Buyers are more productive than sellers in 91.5% of the transactions in the unbundled market. In the bundled market, however, only 46.7% of the transactions involve a productive buyer.[6] Unlike Lanteri (2018), in which the price is so sensitive to aggregate shocks that it turns capital sales procyclical, unbundled reallocation is countercyclical in my model, mainly because the marginal benefit to reallocation during downturns exceeds the marginal cost from the adverse price impact of aggregate shocks. In addition, sales of bundled capital are procyclical and highly correlated with market valuation as more firms involve themselves in opportunistic trading of capital during these high-sentiment periods. This, however, does not imply that bundled capital sales are purely financial plays. On the contrary, less than 10% of firms are subject to the impact of market sentiment during normal periods; this number increases to around 38% during periods of high sentiment. Thus most firms still reallocate bundled capital for purely productivity reasons when it is cost-effective. However, the model does predict higher reallocation efficiency during periods of low sentiment.

[5]The positive externality on reallocation from (sentiment-induced) overinvestment is similar to the externality of new capital investment emphasised in Lanteri and Rampini (2021).

[6]Note that, despite exhibiting comparable or even lower TFP, bundled capital buyers still have greater marginal products than sellers overall.

This paper provides an alternative to the financial friction-based explanations for procyclical reallocation. Importantly, I argue it is "too much liquidity in booms" rather than "too little liquidity in busts" that has contributed to the lack of reallocation efficiency. This is not surprising considering the fact that U.S. public firms—especially large ones—hold significant cash reserves and are rarely financially constrained.[7] Some may worry that the results presented are driven by public firms. To this end, I show that private firm data yield similar results: countercyclical sales of property, plant and equipment in contrast to strongly procyclial divestitures. More importantly, private firms seem to reallocate more efficiently than their public counterparts.[8] One possible reason is that, with limited access to the public equity market, private firms' reallocation decisions are less affected by valuation distortions, consistent with the sentiment channel in the model.

Note that this paper does not imply that reallocation frictions (e.g., financial frictions, adverse selection, liquidity, etc.) are not important in driving the allocation of capital. In fact, I show in the model that reallocation will be rather constrained without the bundled market: firms reallocate much less and reallocation turns acyclical as a result of the adverse price impact from aggregate shocks. However, the evidence does shed light on the important role sentiment plays in shaping the cyclical dynamics of aggregate reallocation through its impact on corporate asset prices.

Finally, to gauge the net impact of sentiment on aggregate TFP, I show that moderate equity distortions that do not affect real asset prices are actually beneficial to the economy: a 1% increase in equity overvaluation, ceteris paribus, increases aggregate TFP by 0.15%. By contrast, a 1% increase in real price distortion, ceteris paribus, reduces aggregate TFP by 0.16%. The counterfactual analysis reveals that aggregate TFP in this economy is 1.4% lower than in an economy with standard assumptions from neoclassical theory.

RELATED WORKS: This paper brings together two strands of related literature that appear to have evolved in isolation: the body of work that explores friction-based explanations of capital reallocation; and the merger wave literature. Using Compustat data, Eisfeldt and Rampini (2006) show that aggregate reallocation is procyclical and contrast it with countercyclical measures of

[7] Both sellers and buyers of capital in my sample hold significant amounts of cash above their industry level throughout the 5 years before and after the reallocation.

[8] Both types of asset sales are positively correlated with productivity growth dispersion, regardless of the economic condition.

benefits to reallocation. Their conclusion is that there must exist a substantially countercyclical degree of friction that impedes efficient reallocation. Along those lines, many scholars demonstrate how procyclical reallocation can emerge as an equilibrium outcome in business cycle models where reallocation become endogenously more costly during downturns (e.g., Eisfeldt and Rampini, 2008; Li and Whited, 2015; Fuchs, Green, and Papanikolaou, 2016; Lanteri, 2018; Ai, Li, and Yang, 2019, Donaldson, Gromb, and Piacentino, 2021). A key implication of this literature is that capital is less efficiently deployed in economic downturns when reallocation is more costly.

By contrast, researchers in the merger wave literature have long established that M&As, a major form of bundled reallocation, tend to cluster in times that coincide with high equity valuation even if industry shocks do not. Nelson (1959), Shleifer and Vishny (2003), and Rhodes-Kropf and Viswanathan (2004) show theoretically how that can result from managerial timing of market overvaluations (sentiment). Supporting evidence is provided by Matthew Rhodes–Kropf and Viswanathan (2005), Dong, Hirshleifer, Richardson, and Teoh (2006), Bouwman, Fuller, and Nain (2007), Savor and Lu (2009), and Baker, Pan, and Wurgler (2012). Valuation sentiment is known to be procyclical,[9] as are M&A waves. Thus the same observation—procyclical reallocation—has been interpreted as evidence of countercyclical frictions hindering efficient asset redeployment by the capital reallocation literature, and that of excessive capital trading in the absence of any synergies by the merger wave literature.

In this paper, I bridge the gap between the two by recognizing two types of capital transactions that have distinctly different motives: (1) Firms mostly adjust capital in the unbundled form in response to productivity shocks because unbundled capital serves better as a homogeneous factor of production and is available at competitive market prices. (2) Firms also reallocate bundled capital, however, the economic motivations are more complicated. One of the reasons is that bundled capital typically comes with its own production technology, which may or may not complement that of the buyer. Such uncertainty renders the asset an inferior substitute for unbundled capital for firms attempting to take advantage of good productivity shocks. Thus, compared to the unbundled market, transactions in the bundled market are less incentivized by productivity dispersion. In addition, without a competitive market, bundled capital is typically hard to value and prone to

[9]The empirical finance literature has documented that, over long horizons of 3 to 5 years, equity prices overreact to consistent patterns of news pointing in the same direction.

misvaluation. The latter opens the door to opportunistic trading. Consistent with existing evidence on M&As, I show that bundled capital sales are highly correlated with market valuation. I further show that, unlike the unbundled market where reallocation is countercyclical and highly correlated with productivity dispersion, the bundled market features procyclical capital sales that bear no consistent relation to productivity dispersion measures. The evidence suggests that, consistent with neoclassical theory, more capital is efficiently reallocated when the benefit from redeployment is greatest. At the same time it also makes clear an inadequacy of the same theory in reconciling the facts about bundled capital sales documented in this paper, shedding light on the importance of the behavioral side of the financial market.

The rest of the paper is organized as follows: Section I presents empirical test results and discussions; Section II describes the model and the calibration method; Section III presents simulation results and counterfactual exercises followed by interpretations; Section IV concludes.

I. Empirical Evidence

In this section, I present new evidence on both the levels and dynamics of the resale prices and reallocation quantities from both used capital markets. Four main facts emerge: 1. Resale prices in both markets are procyclical. 2. The price of unbundled capital is highly sensitive to aggregate output shocks, whereas the price of bundled capital is not. 3. Reallocation of unbundled capital is countercyclical and highly correlated with dispersion in TFP growth. 4. Reallocation of bundled capital is procyclical, highly correlated with market sentiment, and bears no consistent relation to productivity dispersion measures. For external validity concerns, I also reconfirm some of the main results using data of private firms in Section I.D. Finally I compare my results with the existing evidence on capital reallocation using Compustat data.

A. Data

The collection of data turns out extremely challenging because the commonly employed database Compustat obtains information about asset sales from corporate cash flow tables using basic textual matching algorithms. The resulting data quality is unsatisfying: not only does it lack the details

needed for capital classification, but it also contains a lot of missing values and measurement errors as Compustat fails to accommodate the different ways firms report their asset sales.[10]

To deal with these issues, I first electronically extract capital sales items from cash flow tables using a more cautious algorithm.[11] I then complement the items with explanatory information about the sales—the type of capital sold,[12] the transaction proceeds, and the corresponding gains/losses—extracted from corporate 10K filings. For each firm-year in my sample, I manually classify capital sales as either bundled or unbundled; for each type I then aggregate the transaction values and the related gains or losses. Owing to data availability and quality constraints, I restrict my sample to large firms with a market capitalization above the NYSE medium size for the period 1995-2017. Not only do these firms have better 10K filing quality; they also have the most important economic effects due to the mere size of their operations.

Details on the collection procedure as well as summary statistics are provided in the Online Appendix. Private firm data used in Section I.D are provide by the S&P capital IQ platform.

B. Resale prices

Because of data limitations, it is difficult to compile information about used asset prices. There are some exceptions, but most have limited implications because they focus on either specific types of assets or specific types of sales. For instance, Lanteri (2018) documents that resale prices of aircraft are highly procyclical and much more volatile than prices of new capital.[13] CKermani and Ma (2020) find that the liquidation value of PP&E from non-financial firms is around 35%, which corresponds to an average resale price of 0.35.

In this section, I provide new evidence on the levels as well as the business cycle dynamics of resale prices for both types of capital. Three facts emerge: 1. Unbundled capital on average sells at a premium of 1.5% above book value, whereas bundled capital sells at a premium of 37.5%. 2. The price of unbundled capital is procyclical and highly sensitive to aggregate output shocks; 3. Price of bundled capital is less procyclical, and is insensitive to aggregate output shocks.

[10] See Online Appendix for sources of measurement errors and biases in asset sales data from Compustat.
[11] Manual checks of a random sample of 100 suggest the algorithm captures 100% of all reported capital sales.
[12] E.g., equipment, building, division, product line, etc.
[13] The price indices, however, only provide levels relative to a base period and thus do not allow for direct comparison between new and used capital.

In order to study its cyclical dynamics, I first need to measure the price of capital. I compute the price as the ratio of the transaction value to the book value of the capital sold as in Equation (1). Typically when a firm sells an asset, it compares the proceeds from the sale with the carrying value of the asset sold[14]; any surplus is recorded as a gain and any deficit as a loss. Thus I can back out the book value of capital sold based on the proceeds and realized gain/loss from the sale.

$$P_s = \frac{\textit{Transaction value of capital sold}}{\textit{Book value of capital sold}} = \frac{\textit{Sales proceeds}}{\textit{Sales proceeds - Gain/+Loss}}. \tag{1}$$

This measure has several advantages over measures based on absolute market price. First, P_s is directly comparable across assets of different ages and wear-and-tear.[15] Second, P_s can be consistently calculated for different types of assets—be it a building or a business sector, allowing for the construction of an aggregate price measure using prices from different industries.

[Place Table I about here]

Panel A of Table I presents the averages as well as percentiles of the resale prices. Despite significant cross-sectional variation, unbundled capital on average sells at a price ranging from 1.015 using book-value-weighted average to 1.394 using transaction-value-weighted average, whereas bundled capital sells for a price ranging from 1.375 to 2.936. The fact that bundled capital on average sells for a much higher premium than unbundled may not appear surprising in the M&A literature;[16] however, it contradicts neoclassical models, which typically assume the existence of integrated used-capital markets with homogeneous capital. In such a setting, a higher price in one market will attract potential sellers from the other, forcing the two prices to converge.

In addition to the differences in levels, the two also exhibit distinct dynamics, as shown in Panel B of Table I. Specifically, while the unbundled capital price responds strongly to output shocks (correlation with log GDP growth at 0.594), the price of bundled capital is insensitive to such shocks (correlation at 0.092). Correlation with Hamilton filtered GDP is slightly smaller for the unbundled capital price (at 0.552); for bundled capital, however, the correlation increases to 0.155. The fact that the unbundled capital price reacts strongly to aggregate output shocks is consistent with pre-

[14] For fixed asset, the carry value is the cost of the asset less accumulated depreciation; for business unit, the carry value also includes any goodwill attributable to that unit.

[15] Market prices of new and used capital are not directly comparable because used capital has already lost a portion of its value owing to, say, usage-related depreciation or damage-related impairment.

[16] A price premium could be from, say, synergies, growth options, or misvaluation.

dictions of neoclassical models with endogenized capital price, suggesting a supply/demand-driven market responding to aggregate productivity shocks. However, the dynamics of bundled capital price are puzzling and worth further exploration.

To understand the bundled capital price dynamics, it is important to understand the features of different filters. There are three common filters one can use to stationalize GDP data before estimating cyclical correlations. First, the Hodrick–Prescott (HP) filter, originally designed for quarterly macroeconomic time series, is the dominant choice in the literature on reallocation. However, the HP filter can produce spurious cyclical dynamics when applied on difference stationary data such as log annual GDP.[17] In this article I mainly use the Hamilton filter and first-difference filter for inferences. Of these two, first-difference has a clear economic interpretation (first-differenced log GDP is simply the log GDP growth). Even though both filters stationalize GDP, they preserve different features of the data. Intuitively, for a difference stationary process, using first-difference preserves the original dynamics of the series—e.g., transitions of the economy into/out of a recession will have large impact in the log GDP growth data. On the other hand, the Hamilton filter tends to smooth out large shocks, thus prolonging the impact of the shocks.

[Place Table II about here]

In the data, the bundled capital price is less correlated with shocks to GDP than the Hamilton filtered GDP, which tends to prolong the shocks. This pattern resembles the phenomenon of long-term equity price overreaction to consecutive series of good news documented in the empirical finance literature. Barberis, Shleifer, and Vishny (1998) have attributed this phenomenon to investor sentiment. I thus conjecture that sentiment could be an important factor affecting bundled capital price. To verify my conjecture, I first look at the correlation between the average price and the sentiment index, as in column (6) of Panel A in Table II. The correlation is insignificant (-0.16 using book-value-weighted price), surprisingly. However, considering the significant cross-sectional variations, the lack of correlation between the two may not be surprising if sentiment also affects the composition of sales in the market. For instance, a favorable capital environment surely aids in the proliferation of superstar deals with excessive valuations; meanwhile it may also attract a

[17] Interested readers are encouraged to read Hamilton (2018) or Hodrick (2020). In the Online Appendix, I also provide numerical examples in which the HP filter introduces biases in the estimation of correlation between two difference stationary time series.

disproportionate number of bad sellers, most of whom end up with less desirable prices than those observed during normal times—when seller quality is higher. If such a composite effect exists, focusing on the average can conceal important dynamic relations.

To isolate such effects, I look at the correlations between sentiment and selected percentiles of the prices in the bundled market. Indeed, as shown in columns (1)-(5) of Table II, the price is positively correlated with sentiment among the top percentiles (correlation 0.41 at the 95th percentile); the estimate turns more robust (0.43 with a t-stat of 2.07) after I control for the influence of aggregate economic conditions (Panel B). Additionally, sentiment is negatively correlated with prices at lower percentiles (consistent with my earlier conjecture that more deals are done at less favorable prices), resulting in an insignificant correlation between the average price and sentiment. By contrast, pricing in the unbundled market seems to be consistent across all transactions, which is not surprising when related to the homogeneous capital assumption.

The evidence seems to suggest segmentation of the corporate asset market between unbundled and bundled assets. Specifically, price dynamics in the unbundled market are consistent with a supply/demand-driven reallocation market responding to aggregate shocks. By contrast, price dynamics in the bundled market exhibit features distinct from those of a competitive market with homogeneous capital—e.g., transactions are done at different prices with distinct dynamics. A small group of firms strike extremely favorable prices that are highly sensitive to investor sentiment but not to output shocks.

C. Reallocation quantities

Most of the existing evidence on capital reallocation is restricted to transaction values—price times quantity—because the studies typically use Compustat data, which only contains sales proceeds. There are a few exceptions: Maksimovic and Phillips (2001) find that the share of plants changing ownership is procyclical in the manufacturing industries. Lanteri (2018), on the other hand, documents that the number of aircraft traded in the used capital market is also procyclical. Intriguing as these results are, their implications are restricted to specific industries. In this paper I study capital reallocation using a representative sample including all non-financial/utility industries. More importantly, I am able to separately examine the cyclical dynamics of reallocation for two types of distinct capital: unbundled and bundled.

The fact that prices are procyclical (as shown in Section I.B) makes it important to control for the impact of price when analyzing the cyclicality of reallocation. To do that, I construct a measure of capital reallocation free from the impact of resale price:

$$Reallocation\ Turnover_t^{Book} = \frac{Capital\ Sale_t^{Bval}}{Capital\ Stock_{t-1}^{Bval}}, \tag{2}$$

where $Capital\ Sale^{Bval}$ is the book value of capital sold, computed as

$$Capital\ Sale^{Bval} = Sales\ proceeds - Gain(+Loss), \tag{3}$$

and $Capital\ Stock^{Bval}$ uses the book value of net PP&E for unbundled capital and total assets for bundled capital. This ratio measures the relative quantity of reallocation that is not contaminated by current asset prices. For comparison with the existing literature, I also construct a similar ratio of reallocation value, which simply uses sales proceeds as the numerator in Equation (2).

[Place Table III about here]

I now turn to the results of my empirical investigation. Table III presents correlation estimates between output and reallocation turnovers for both types of capital. A couple of observations emerge: First, contrary to the common perception on aggregate reallocation, unbundled capital sales are highly countercyclical (cyclical correlation at -0.4). On the contrary, bundled capital sales are procyclical (cyclical correlation at 0.37); aggregate reallocation is procyclical as well, although the coefficient at 0.13 appear much smaller than the 0.54 documented in Eisfeldt and Rampini (2006). However, if I follow the exact same methodology as the existing literature—using reallocation value instead of quantity and using the HP filter on both series before the estimation of correlations, the correlation is much larger (at 0.44). These distinct patterns of reallocation between unbundled and bundled capital remain when we switch to first-difference as the GDP filter. Note that for unbundled capital, the correlations using reallocation value are insignificantly different from zero (0.021 under Hamilton and 0.026 under first-difference), which underlines the importance of isolating the impact of prices in studies of capital reallocation.

The emphasis the literature has placed on the cyclicality of reallocation has eclipsed a fundamentally more important question: Do firms reallocate more when dispersion in productivity is

greater? This question is important because, at the end of the day, what we care about is productivity gains, not simply cyclicality.

[Place Table IV about here]

In panel A of Table IV, I compute the correlations between reallocation and measures of productivity dispersion. Productivity dispersion is measured in three different ways both within industry and across industries. First is the standard deviation (s.d.) of TFP growth as in column (1) for within-industry and column (4) for cross-industry. Second is the difference between the top and bottom quartiles (q3-q1), and last is the difference between the top and bottom percentiles (p90-p10). As we can see, reallocation of unbundled capital is highly correlated with dispersions in TFP growth, both within (from 0.29 using s.d. as measure of dispersion to 0.42 using p90-p10) and across industries (from 0.38 to 0.57). On the other hand, such correlation is less clear-cut for bundled capital, being positive for some measures and negative for others.

In panel B, I also report the correlations of reallocation with dispersion measures in Tobin's Q, which has been interpreted by many as an alternative measure of productivity. Interestingly, reallocation of unbundled capital bears no relation to Q dispersions, whereas bundled capital sales are highly correlated with these measures. One potential reason could be that Tobin's Q, measured as the ratio of market value to book value of total assets, contains less information about productivity but more information about factors (e.g. valuation) that affect reallocation decisions in the bundled market but not in the unbundled market.

Consistent with neoclassical theory, productivity appears to be a key driving factor of reallocation in the unbundled market. However, the relation is not clear-cut for the bundled market. You may ask, what is causing this discrepancy in the reallocation dynamics between these two markets? To answer this question, it is helpful to think about the unique features of bundled capital. Unlike its unbundled counterpart, which typically has a market with relatively competitive prices, bundled capital, similar to the targets in the acquisition market, is typically hard to value and prone to misvaluation. For these complex assets, Shleifer and Vishny (2003) have shown that investor sentiment plays an important role in the related reallocation decisions. Similarly, I conjecture that sentiment may have a large impact on reallocation in the bundled market.

[Place Table V about here]

To test this conjecture, I compute the correlations between reallocation and several proxies of valuation sentiment, including the percentage of firms with Q above certain thresholds, quartiles of Q, average level of Q, and the sentiment index data from Professor Jeffrey Wurgler's website. The estimates are tabulated in Table V. In line with my conjecture, bundled capital sales are highly and significantly correlated with valuation sentiment across all proxies, which is not surprising since similar facts have been documented in the MA literature. However, what is new and interesting here is that, in the unbundled market, reallocation bears no relation to Q measures of sentiment.

[Place Table VI about here]

To see whether the high correlation between bundled reallocation and market valuation is driving the results in Panel B of Table IV, I regress bundled reallocation on both dispersion in Q and market valuation measures. The coefficients are tabulated in Table VI. As we can see, although the coefficient on Q dispersion is positive (0.38), it decreases (0.24) or turns negative (-0.29) after controlling for proxies of valuation sentiment, indicating that sentiment is an important factor driving the positive correlation between bundled capital sales and Q dispersion.

To wrap up, in this subsection, parallel to the evidence on resale prices, I document distinct patterns of reallocation between the two used capital markets. Specifically, in the unbundled market where capital is closer to a homogeneous factor, reallocation is countercyclical and highly correlated with dispersion in productivity growth. Thus firms indeed reallocate more during times when benefits from reallocation are greater, regardless of the economic condition. By contrast, in the bundled market where capital is complex and hard to value, reallocation is procyclical, highly correlated with valuation sentiment, and bears no consistent relation to productivity dispersion measures.

D. Evidence from private firm data

The main data employed above are collected from 10Ks of public firms. To address any concern about the external validity, I present comparable results using private company data from S&P Capital IQ Platform ("CIQ" thereafter).

Like Compustat, CIQ collects capital sales data from private companies' financial statements when available.[18] As a result, similar data limitations likely apply. For private firms, however, I

[18] E.g., some private firms voluntarily disclose their financial reports

argue that these issues are less severe. As a noisy measure of piece-wise capital sales, the Compustat item "sales of PP&E" may also include proceeds from other asset sales—these other assets may be a division, a subsidiary or even investment securities. Because private firms are typically smaller than public firms—they are often single-segment firms that are less likely to hold miscellaneous assets, I argue that their "sales of PP&E" measure is more likely to be unbundled capital sales.

Compustat also lacks good quality price data for capital sales. The item "SPPIV" records gains and losses realized from sales of assets. However, similar to "sales of PPE", it often includes gains or losses from sales of miscellaneous assets, such as short-term equity investment. For private firms, Capital IQ provides a similar item, "gain/loss on sale of assets"; I argue that this item is cleaner for private firms, both because they do not invest as much in miscellaneous assets as large public firms do, and because Capital IQ has a separate item for equity sales, "gain/loss on sale of investment." Another advantage of these private firm data is that they contain two extra items that are not present in Compustat: "divestiture" and "cash acquisitions." Divestiture can be used as a proxy for bundled capital sales. More importantly, data on cash acquisitions provide me with potentially valuable information to distinguish the sentiment channel from neoclassical arguments.[19]

In this section, I examine the business-cycle dynamics of reallocation for private firms. Similar to the main tests, two types of capital are studied: sales of PP&E and divestitures. I also look at the time series dynamics of cash acquisitions. Three main observations emerge: (1) Reallocation of PP&E is countercyclical and highly correlated with TFP growth dispersion. (2) Reallocation in the form of divestitures is highly procyclical, and also positively correlated with dispersion in TFP growth. (3) Cash acquisitions are highly negatively correlated with market valuation measures constructed using Tobin's Q of public firms. All results are tabulated in Table VII.

[Place Table VII about here]

As in Table VII, the distinctive cyclical patterns of PP&E sales and divestitures resemble those of unbundled and bundled sales of capital by public firms. However, different from their public counterparts, both PP&E sales and divestitures by private firms correlate positively with productivity dispersion (although the positive correlation is weaker for divestitures), indicating that

[19] Neoclassical theory does not distinguish between cash and non-cash payments in asset acquisitions. Shleifer and Vishny (2003) construct a model of sentiment that reproduces the distinct patterns on method of payments (cash versus non-cash) in M&As. One of the model's central predictions is that acquisitions are more likely to be non-cash when market valuations are high, and in cash when they are low.

private firms overall reallocate their assets more efficiently than their public counterparts. This may not be surprising since private firms generally have limited access to the public equity market;[20] their capital reallocation decisions thus are less affected by equity valuation distortions. This may also help explain the overall insignificant or even negative correlation between divestitures and equity market valuation proxies in panel D. Interestingly, again in panel D, not only are divestitures negatively correlated with equity market valuation measures, but so are sales of PP&E. Although almost none of these estimates are significant, they are indicative of potential substitution between the public market and private market. Last, in line with Shleifer and Vishny (2003), cash acquisitions are significantly negatively correlated with market valuation, suggesting sentiment as an important factor in shaping firms' reallocation decisions.

E. Discussion

Using Compustat data, Eisfeldt and Rampini (2006) document a correlation between GDP and aggregate value of reallocation of 0.54. I document a much smaller correlation at 0.13. There are a couple of reasons for this discrepancy. One is the impact of used-capital price. In Panel A of Table III, I show that using value rather than quantity of reallocation increases the correlation from 0.13 to 0.35. The other is the choice of GDP filter. Again in Table III, applying the HP filter to both reallocation and GDP increases the correlation from 0.13 to 0.27. These two together bring the final correlation to 0.44, which is still smaller than the 0.54 documented in Eisfeldt and Rampini (2006). I attribute this difference to data quality issues from Compustat.

The bias in the cyclical dynamics introduced by using value (price times quantity) rather than quantity is obvious: the value of reallocation can be procyclical even if the quantity is not, because the resale price of capital is strongly procyclical. The bias introduced by the HP filter is subtler. The reason we want to filter GDP data is because it is non-stationary and correlations do not exist for non-stationary data. The HP filter is essentially an MLE estimator intended to produce a stationary process from an I(2) or a process with higher integration order (e.g., quarterly data). Annual log GDP, however, is difference stationary in the data.[21] In theory, the HP filter is undefined for I(1) because one of the key assumptions of the estimator is violated (proof

[20] With the rising popularity of SPACs (special purpose acquisition companies), access to public equity funds by private entities has become easier over the years.

[21] Hamilton (2018) also cites several studies supporting the random-walk hypothesis for annual GDP data.

available upon request). In practice, using the HP filter on an I(1) process can generate spurious cyclical dynamics, which has no basis in the underlying data generating process.[22] Last, measurement issues—e.g., sales of PPE data include sales-leasebacks, proceeds only recorded when the cash is received rather than when the sale occurred—in asset sales data from Compustat can also generate bias in the cyclical dynamics. Details of these issues are explained in the Online Appendix.

Using global data on secondary markets for aircraft and ships, Lanteri (2018) shows that both the resale prices and reallocation quantities are procyclical. In this paper, I document that the price of unbundled capital in other industries is also procyclical. My findings on relocation quantities differ, however, in that Lanteri (2018) finds aircraft sales to be highly procyclical. Although industry-specific, evidence on aircraft sales is interesting by itself due to the uniqueness of the capital: high unit value with a large leasing market. In the Online Appendix, I discuss transactions common in industries such as airlines that can potentially explain the procyclicality: aircraft trading and sale-leaseback.

Using census data for manufacturing industries, Maksimovic and Phillips (2001) find that both full-firm (mergers, for instance) and partial-firm sales (division sales, for instance) are procyclical. Similarly, I find that bundled capital sales (including both partial and full division) are procyclical for all other non-finance/utility industries. On the role of productivity shocks, Maksimovic and Phillips (2001) find that although partial-firm sales tend to be driven by productivity shocks, M&As do not. Correspondingly, they find that partial-firm reallocation overall increases productivity, whereas M&As do not. Their firm-level evidence is generally in line with the macro evidence presented here in the sense that reallocation of the more homogeneous type of capital is more likely to be driven by productivity shocks.

That being said, their measure of partial firm sales indeed falls into the bundled sales category. I argue that the capital homogeneity assumption holds reasonably well for plant sales in Maksimovic and Phillips (2001) because they only focus on reallocation within manufacturing industries.[23] In addition, the distinction between unbundled and bundled capital is not always exact in the data. In

[22] See Hamilton (2018) for examples with real consumption and stock price data.
[23] more than 63% of the partial-firm sales are made within the same 3 SIC code.

manufacturing industries in particular, sales of plants are more likely to be classified as unbundled than in other industries, because manufacturing firms tend to report property/equipment and plant sales in aggregate without detailing the proceeds. By contrast, sales of divisions and M&A transactions can be cleanly identified as bundled capital sales.[24] Even though my data on unbundled sales may contain plant sales, especially for manufacturing firms, the economic distinction between these two types of capital is clear-cut: unbundled capital serves better as a homogeneous factor—easier to adapt to different productivity levels—and bundled capital less so.

II. An Investment Model with Valuation Sentiment

To better understand corporate reallocation decisions and their impact on the aggregate TFP, I construct an investment model that is related to neoclassical theory, but also able to accommodate the additional empirical regularities: e.g., the price and reallocation dynamics in the bundled capital market are distinctly different from that in the unbundled capital; bundled reallocation is highly sensitive to aggregate equity valuation whereas unbundled reallocation is not.

The model has three distinguishing features: (1) There are two types of firms. Type I is normal firms whose equity price always reflects efficient valuation of the company's operations. Type II is popular firms whose equity price is subject to sentiment-related distortions when they announce deals to acquire bundled capital. Here I mainly focus on distortions around bundled acquisitions—e.g., marginal investors perceive the acquisition as more beneficial than it is in reality.[25] This assumption is needed to generate the distinctive reallocation dynamics of both types of capital. (2) There exist two distinct used-capital markets. One for unbundled capital whose price is endogenously determined by the market clearing condition. The other for bundled capital whose price depends on the type of firms involved in the transaction. This assumption is needed to generate the distinct price levels in both markets.[26] (3) I allow for the possibility of structural changes in a firm's TFP following successful acquisition of bundled capital. This assumption fun-

[24] For other industries, we observe separate items more often—e.g. Mcdonand: "sales of restaurant" and "sales of properties."

[25] Internet-related companies during the dot-com bubble are an intuitive example of companies affected by such distorted perceptions.

[26] Endogenizing the unbundled capital price also generates procyclical prices as in the data.

damentally distinguishes bundled capital from unbundled capital—acquisition of bundled capital comes with uncertainty, for example, because of synergy or "empire building" discount. These features enable me to rationalize the empirical regularities documented in the paper. The following sections introduce the model setup as well as the details of each feature above.

A. Firm heterogeneity

For normal firms, the managers' role of value optimization is equivalent to maximizing the present value of current and future cash flows from production and investment. Popular firms are those with valuations highly sensitive to broad waves of investor sentiment.[27] For these firms, absent agency frictions, the role of the manager is to maximize the current shareholder value, which comes from cash flows from production and investment as well as any gains realized from the equity market due to misvaluation.

B. Production technology

Both normal firms and popular firms share the same set of production technologies. Firms produce a common good using capital as the only input, they are fully equity financed, there is no cost of raising capital, and proceeds are paid out in each period. Each firm employs capital k to produce goods $\pi = exp(z_a, z_i)k^\alpha$, where $0 < \alpha < 1$ (DRS) and (z_a, z_i) are productivity (or demand) shocks at the aggregate level and firm specific level respectively.

In the model, business cycles are mainly driven by aggregate productivity shocks, which follow an AR(1) process with mean 0 and standard deviation of error term σ_a. The idiosyncratic shock follows a threshold AR(1) process with mean 0 and standard deviation of error term σ_i:

$$z_{a,t} = \rho_a z_{a,t-1} + \epsilon_a, \quad z_{i,t} = f(z^j_{i,t-1}) = \sum_{j\in\Omega} \rho^j_i z^j_{i,t-1} + \epsilon_i, \tag{4}$$

where Ω denotes the state space of aggregate shocks. Intuitively, it states that the persistence level of idiosyncratic shocks changes with the current state of aggregate shock (explained later).

[27] I do not explicitly model the source of such sentiment but rely on a growing literature on the circumstances under which equity prices can deviate from fundamentals.

At the beginning of each period, firms observe the realization of productivity shocks and determine whether to invest in new capital ($I_t >= 0$), to buy or sell used unbundled capital (U_t), or to propose acquisition or divestiture (B_t) in the bundled capital market. Acquisitions and divestitures can fail.[28] In case they fail, no assets will be reallocated; denote the final transaction quantity as $\bar{B}_t$, which is either 0 or B_t. Firms are allowed to invest in new capital while reallocating used capital at the same time, but participation in the two used-capital markets is mutually exclusive. Firms are not allowed to sell more capital than they already own. I assume there is a timing difference between new and used capital investment: new capital takes one period to be built for production, whereas used capital can be put into production in the current period.[29] This is intuitive—e.g., new office buildings take time to build but used buildings, once acquired, can be put to use immediately.

C. Segmented used capital market

In the unbundled market, capital is a homogeneous factor of production whose price (p^u) competitively clears the market.

$$\sum_j U(k_{jt}, z_{ijt}, z_{at}, z_{at-1}, p_t^u) = 0, \tag{5}$$

where k_j, z_{ij}, and z_a denote the capital level, idiosyncratic productivity shock for firm j, and aggregate productivity shock, respectively. In equilibrium, p_t^u is determined by Equation (5), which requires information about capital decisions of all firms in the economy.

$$p_t^u = f(z_{a,t}, z_{a,t-1}, K_t, Z_{it}), \quad where\, K_t = (k_1, ..., k_n),\ Z_{it} = (z_{i1,t}, ...z_{in,t}). \tag{6}$$

By contrast, the market for bundled capital resembles the M&A market: firms can propose to buy or sell; deal completion, however, is not guaranteed and occurs with probability P_o. Unlike unbundled capital, which simply adapts to the TFP of its new owner, bundled capital, once acquired, can potentially change the productivity state of the acquirer ("structural change"). Specifically, following a successful acquisition, there is likelihood P_s that acquirer i will experience a change in its state variable from $z(z_a, z_i)$ to $\tilde{z}(z_a, \tilde{z}_i)$, which affects the transition probabilities to the next

[28] Because I do not have market clearing condition in the bundled market, I need the failure rate to constrain the activity of popular firms.

[29] The timing difference is to avoid the trivial scenario in which used capital price is bounded by new capital price.

period (the next shock z' will be drawn from $F(z'|\tilde{z})$ instead of $F(z'|z)$).

In the data, capital in the bundled market is overpriced on average, and transactions occur with highly dispersed prices. In the model, for the sake of simplicity, the bundled capital price is assumed to have two levels, depending on whether the buyer or seller is a normal firm or a popular firm embraced by market sentiment. Specifically, p_n^b is the capital price faced by normal firms, and p_s^b is the price for popular firms in the bundled market.

Last, quadratic adjustment cost applies to new investment; for unbundled capital, both fixed cost and quadratic cost apply (typical assumption in the literature):

$$C_I(k,I) = \frac{\gamma}{2}(\frac{I}{k})^2 k, \quad C_U(k,U) = \frac{\gamma}{2}(\frac{U}{k})^2 k + f_U \cdot \mathbb{1}_{U\neq 0}. \tag{7}$$

Propositional cost of acquisition/divestiture in the bundled capital market:

$$\begin{aligned} C_B(k,B) &= \phi k \cdot \mathbb{1}_{\bar{B}\neq 0} \\ \bar{B} &= \begin{cases} B, & \text{deal completion with prob. } \mathsf{P}_o \\ 0, & \text{otherwise,} \end{cases} \end{aligned} \tag{8}$$

which captures forgone operating profit from processing bundled capital transactions.

D. Rationalizing the price and reallocation dynamics in the bundled market

There are many reasons why premiums paid for bundled capital are so high. It could be that the labor associated with such capital is more valuable to the acquirers—who lack the talents capable of managing the capital—than the original owner. However, such explanation begs the question why the acquirer not search for other cheaper alternatives—maybe a lack of similar targets? It could also be the case that bundled acquisitions bring significant synergies. Although the empirical facts—e.g., firms divested almost 44% of their targets acquired during the period between 1971 and 1982 by the end of 1989 (Kaplan and Weisbach, 1992)—appear less encouraging. The high correlations of bundled transactions with aggregate market valuation and investor sentiment lead me to pursue an alternative story similar in spirit to Shleifer and Vishny (2003). Specifically, I conjecture that marginal investors—with ample funds and desire for capital returns—hold irrationally expectations

about the benefits of certain bundled transactions. Note this does not imply that other alternative explanations are not important. The reality is complicated, and no model can accommodate all factors at once. By focusing on the sentiment channel, the model provides upper bound estimates of the impact of sentiment on aggregate reallocation and thus productivity.

Equity price distortions occur when marginal investors value acquisitions by certain firms as more beneficial than they are in reality: e.g., upon deal announcement, the equity value of the acquirer rises, reflecting "perceived benefits" of the deal by the euphoric market.[30] In practice, such an optimistic outlook could be induced by a story of synergy or any story invented by investment bankers.[31] When the distortion is high enough, the firm manager has an incentive to acquire capital even when the acquisition may result in zero or even negative gain in production profit. This is because, by striking the deal, the manager can create value for the existing shareholders by financing with overvalued stocks. Intuitively, such an incentive can cause the manager to overpay for the target; p_s^b thus should be higher than p_n^b.[32] This mechanism resembles that of acquisition for stocks, a commonly used strategy in the M&A market that is particularly popular during periods of high market valuation.[33]

Sentiment in this model has two dimensions. One is the percentage of popular firms (S_t) in the economy that are subject to a euphoric view of acquisitions. The other dimension captures the magnitude of the equity price distortion upon announcement of acquisitions; this distortion is defined in relation to the size of the target asset, which I will explain later.

I make two additional assumptions about each of the above two dimensions. First, following

[30] E.g., Matsusaka (1993) documents that buyers earned significantly positive announcement returns during the conglomerate merger wave (sentiment for diversification) when they made diversifying acquisitions; Morck, Shleifer, and Vishny (1990) also find that the stock price of buyers rose when they acquired firms catering to the concurrent sentiment toward specialization in the 1980s.

[31] An extreme example being SPACs, which are created specifically to pool funds to finance a merger or acquisition that has yet to be identified. Recent rallies in pre-merger SPAC prices see speculative investors betting on blank-check deals without valuation or an actual business.

[32] In a study on the performance of divestitures during the takeover wave in the '1980s, Kaplan and Weisbach (1992) report that for deals with comparable sale prices, targets are sold at 192% of their purchase price, which when adjusted for the contemporaneous increase in the SP 500 index, equals 90% of their purchase price and 143% of their market value before the initial takeover announcement.

[33] Nelson (1959) find that acquisitions cluster during periods of high market valuation and the method of payment is generally equity. Shleifer and Vishny (2003) cite two other studies that also document a high correlation between market valuation and popularity of stock acquisitions.

consecutive good aggregate shocks, the percentage of popular firms in the economy increases:

$$S_t(z_{at}, z_{at-1}) = S_o + \delta_s \cdot \mathbb{1}_{(z_{at}=H, z_{at-1}=H)}. \tag{9}$$

S_o is the percentage of popular firms during normal periods and δ_s captures the spike in this number following consecutive good aggregate shocks ($z_a = H$). This assumption is important in generating the cyclicality in aggregate equity valuation and bundled reallocation. It is inspired by the documented phenomenon in the empirical finance literature: after consecutive good news, equities tend to receive extremely high valuations, which are later followed by reversions on average.[34]

Second, I assume marginal investors value bundled acquisitions by popular firms at $b\%$ over the book value of the target asset. E.g., if the target asset contains one unit of capital, the assumption states that marginal investors are willing to give the firm $1 + b$ in cash to acquire the asset. Note that these euphoric views have little to do with the fundamentals of the specific firm. However, they do affect firms' reallocation decisions, for reasons explained below.

The equity market does not play a role in typical neoclassical models because there is no value distortion, meaning the net present value (NPV) from equity financing is zero. In this model, the equity market can have a large impact on corporate reallocation. This is because, by financing acquisitions with overvalued equity, for each unit of capital acquired, existing shareholders can pocket a cash profit of $1 + b$ minus the unit price paid. E.g., raising \$2 while issuing \$1 worth of equity results in an extra \$1 available as a dividend to existing shareholders. Here I am framing it as a cash benefit for modeling convenience. You can think of it as any similar incentive on the existing shareholders' side: e.g., extra utility from positive price responses to such acquisitions.

Valuation distortion serves as the lubricant facilitating capital buys and sales by popular firms in the bundled market. The effect on the sell side is obvious: the potential to sell at an extremely favorable price attracts otherwise non-movers into selling bundled. On the buy side, supported by high valuation, potential buyers who would otherwise only buy at a price below x are now willing to enter the market at a much higher price threshold. Note that since I fix the bundled capital price at two levels, not all sales in the bundled market will be offset by buying orders. Firms as a whole may end up selling or buying more than they have bought or sold depending on the market

[34] See Barberis et al. (1998) for a review of related literature.

condition and industry structure.[35]

Using a sentiment-based acquisition model, Shleifer and Vishny (2003) demonstrate that the proliferation of stock acquisition around periods of high market valuation is consistent with firms timing market inefficiencies by acquiring assets using overvalued stocks. In their model, whatever gains the acquirer garners will be losses to the target because the acquirer pays the target with its overvalued equity. In my model, both the buyer and seller benefit because the loss is borne entirely by the euphoric investors who pay for overvalued equity.

E. Capital reallocation decisions

At the beginning of each period t, the firm manager optimally makes capital decisions (I_t, U_t, B_t) to maximize current shareholder value based on the firm's existing capital level, realized productivity shocks, capital prices (new capital price normalized to one; the price of bundled capital is p_n^b for normal firms and p_s^b for popular firms), and the potential financing benefit from a bundled acquisition (for popular firms only). Investment in new capital takes one period to be ready for production, whereas used capital, once acquired, can be put into production immediately.

For normal firms, in the event of successful completion (prob. P_o), the buyer(seller) pays(gets) a per unit capital price of p_n^b. For popular firms, in the event of successful completion, the buyer pays a unit capital price of p_s^b while at the same time pocketing a cash benefit from financing the deal with overvalued equity; the seller gets a unit capital price of p_s^b.

For both types of firms, with probability P_s, acquired bundled assets may alter the trajectory of the acquirers' future productivity shocks, as described in Section II.C. Specifically, with two idiosyncratic productivity states, bundled acquisition exposes the productive firms to risks of technology disruption but provides the less productive ones potential benefits of synergy. Figure 1 illustrates the timeline of the whole process.

[Place Figure 1 about here]

For both types of firms, the cash flow generated from operating and investing activities in period

[35] In my sample, firms on average acquire more than they sell (e.g., from other public firms or private firms). Additionally, during high sentiment periods, the percentage of firms selling bundled assets increases by 11.2%, whereas the number drops by 10.9% for acquiring firms.

t, without entering the bundled capital market is:

$$\pi^u(k, z_i, z_a, z_{a,-1}, p^u) = e^{z_i+z_a}(k+U)^\alpha - (I+C_I) - (p^u U + C_U). \tag{10}$$

For normal firms, the expected cash flow conditional on entering the bundled market ($B_t \neq 0$) is:

$$\begin{aligned}\pi_n^b(k, z_i, z_a, z_{a,-1}, p^u) = {} & \mathsf{P}_o\{e^{z_i+z_a}(k+U+B)^\alpha - p_n^b B - C_B\} \\ & + (1-\mathsf{P}_o)\{e^{z_i+z_a}(k+U)^\alpha\} - (I+C_I) - (p^u U + C_U).\end{aligned} \tag{11}$$

For popular firms, the cash flow also includes a potential financing benefit (bB_t):

$$\begin{aligned}\pi_s^b(k, z_i, z_a, z_{a,-1}, p^u) = {} & \mathsf{P}_o\{e^{z_i+z_a}(k+U+B)^\alpha - p_s^b B - C_B + bB\} \\ & + (1-\mathsf{P}_o)\{e^{z_i+z_a}(k+U)^\alpha\} - (I+C_I) - (p^u U + C_U).\end{aligned} \tag{12}$$

I omit the subscripts "t" in Equation (10)-Equation (12) for simplicity.

The firm's optimization problem can be described using the following Bellman equations, which define the value of the firm as the discounted value of expected current and future cash flows. The value of firm i (of type $\zeta \in \{normal, popular\}$) without entering the bundled capital market is:

$$\begin{aligned}& V_{i\zeta}^u(k, z_i, z_a, z_{a,-1}, p^u) \\ & = \max_{\substack{I\geq 0,\, U\geq -k,\, B=0 \\ k'=(k+U)(1-\delta)+I}} \pi^u + \beta E(V_{i\zeta}(k', z_i', z_a', z_a, p^{u\prime}|z_a, z_i, p^u)).\end{aligned} \tag{13}$$

The value conditional on entering the bundled capital market is:

$$\begin{aligned}& V_{i\zeta}^b(k, z_i, z_a, z_{a,-1}, p^u)) \\ & = \max_{\substack{I\geq 0,\, U\geq -k,\, B\geq -k,\, U+B\geq -k \\ k'_{nc}=(k+U)(1-\delta)+I,\, k'_c=(k+U+B)(1-\delta)+I}} \pi_i^b + \beta\Big\{(1-\mathsf{P}_o)E(V_{i\zeta}(k'_{nc}, z_i', z_a', z_a, p^{u\prime}|z_a, z_i, p^u)) \\ & \quad + \mathsf{P}_o\big\{\mathbb{1}_{B>0}\big(\mathsf{P}_s E(V_{i\zeta}(k'_c, z_i', z_a', z_a, p^{u\prime}|z_a, \tilde{z}_i, p^u)) + (1-\mathsf{P}_s)E(V_{i\zeta}(k'_c, z_i', z_a', z_a, p^{u\prime}|z_a, z_i, p^u))\big) \\ & \quad + \mathbb{1}_{B<0}E(V_{i\zeta}(k'_c, z_i', z_a', z_a, p^{u\prime}|z_a, z_i, p^u))\big\}\Big\}.\end{aligned} \tag{14}$$

Optimization thus gives

$$V_{i\zeta}(k, z_i, z_a, z_{a,-1}, p^u) = max\{V^u_{i\zeta}, V^b_{i\zeta}\}, \quad \zeta \in \{normal, popular\}, \tag{15}$$

where $z_{a,-1}$ denotes aggregate shock one period before the optimization period. β is the discount factor; state variables with a prime indicate value of the state at the beginning of the next period.

F. Recursive equilibrium

A recursive equilibrium exists in such an economy if the above-described dynamic programming problem has a fixed point. To describe the equilibrium, I first define the policy functions of the firm. Let $I(k, z_i, z_a, z_{a,-1}, p^u)$ be the firm's decision rule for new capital investment. Similarly, $U(k, z_i, z_a, z_{a,-1}, p^u)$ is the policy rule for unbundled capital investment/divestment and $B(k, z_i, z_a, z_{a,-1}, p^u)$ for bundled capital. In addition, let $L(K, Z_i)$ be the distribution of capital and idiosyncratic shocks across firms in the economy, which follows the law of motion $L_t = \Gamma(L_{t-1}, z_{at}, z_{at-1})$. L determines the equilibrium price of used unbundled capital as in Equation (5). Note that the policy functions differ for the two types of firms ($(I, U, B)^{normal}$ and $(I, U, B)^{popular}$). I omit the superscripts in the following for simplicity of notation.

DEFINITION 1: *A recursive equilibrium is a set of functions* I, U, B, V, k', Γ, p^u *that solve the firm's optimization problem and clear the market for unbundled used capital:*

- *Value function* V *satisfies Equation* (15)*; policy functions* $\{I, U, B; k'\}$ *solve the optimization problems as in equations* (13)-(14) *given the pricing function* p^u *and law of motion* Γ.
- $p^u(L, z_a, z_{a,-1})$ *clears the unbundled capital market as in Equation* (5).
- Γ *describes the evolution of the distribution of capital as well as the productivity level across the industry consistent with* k' *and the Markov process of* $\{z_a, z_i\}$.

G. *Numerical Solutions*

Owing to the high dimensionality of certain state variables $L = (Z_i, K)$, a numerical solution is computationally infeasible. I follow the methodology proposed by Krusell and Smith (1997) to tackle this issue. Specifically, I approximate the distribution of capital by its first moment, mean capital $\bar{K}$. Agents perceive the law of motion as:

$$log(\bar{K}') = \alpha_0 + \beta_0 log(K) + (\alpha_1 + \beta_1 log(K))\mathbb{1}_{z_a^{hl}} + (\alpha_2 + \beta_2 log(K))\mathbb{1}_{z_a^{lh}} + (\alpha_3 + \beta_3 log(K))\mathbb{1}_{z_a^{ll}}, \quad (16)$$

where $\mathbb{1}_{z_a^{hl}}, \mathbb{1}_{z_a^{lh}}, \mathbb{1}_{z_a^{ll}}$ are indicator functions for the pairs of current and previous aggregate shock realizations $(z_a, z_{a,-1})$: z_a^{hl} indicates a high aggregate productivity state following a previous low aggregate productivity state; similarly, z_a^{lh} indicates a low aggregate state after a previous high state and z_a^{ll} two consecutive low states. The pair of parameters (α_0, β_0) thus describes the LOM following two consecutive high productivity shocks (z_a^{hh}). The perceived pricing function is:

$$p^u = \gamma_0 + \phi_0 log(K) + (\gamma_1 + \phi_1 log(K))\mathbb{1}_{z_a^{hl}} + (\gamma_2 + \phi_2 log(K))\mathbb{1}_{z_a^{lh}} + (\gamma_3 + \phi_3 log(K))\mathbb{1}_{z_a^{ll}}. \quad (17)$$

As in Krusell and Smith (1997), the two approximations achieve very high accuracy, with R^2 reaching 0.99 for Equation (16) and 0.98 for Equation (17).

Given these laws of motion (LOMs), I obtain firms' policy functions by value function iteration. I then simulate a panel of 3,000 firms for 600 periods using these decision rules. For each period, I solve the price of unbundled capital that clears the market and calculate the mean aggregate capital for the next period based on the decisions of all firms. Using these data, I update the LOMs for both the mean capital and the price along with each simulation until the parameters in equations (16)-(17) converge.

[Place Table VIII about here]

I calibrate the model using collected data on bundled and unbundled sales and Compustat data on acquisitions. Table VIII presents standard parameter choices. Parameters β, δ correspond to an annual discount rate of 7.5% and a capital depreciation rate of 10%.[36] I set α to 0.592 in the

[36] Although the choice of δ is common in the literature, the discount rate is slightly higher than the common value around 5%. But I believe it's a reasonable approximation of the investor required rate of return in the U.S. This choice is also close to the 6.5% used in Gomes (2001).

production and ρ_a, σ_a to 0.75 and 0.05 as in Cooper and Haltiwanger (2006).

One deviation from the literature is the modeling of idiosyncratic shocks. The prior literature typically assumes independence between aggregate and idiosyncratic shocks. However, with independent shocks, cross-firm dispersion in productivity growth is counterfactually procyclical. In this model, I assume that idiosyncratic shocks follow a threshold AR1 process in which the persistence level varies depending on the aggregate productivity level. To match an average boom-bust ratio of productivity growth dispersion of 0.85 in the data,[37] I use a persistence level of 0.55 when aggregate productivity is high and 0.9 when aggregate productivity is low. (Estimating the persistence level of such a process without conditioning on aggregate states produces an AR1 coefficient of 0.77 in simulation, a value commonly used in the literature for idiosyncratic shocks.)

The calibration follows two steps. First, to get initial parameter values I estimate the model to match 11 distinguishing moments related to resale prices and reallocation using simulated method of moments. These moments include the average levels of both types of capital sales ($E(U)$, $E(B^-)$) and acquisition ($E(B^+)$), their correlations with total output($\rho(U,Y)$, $\rho(B^-,Y)$, $\rho(B^+,Y)$), correlation of bundled sales with market valuation $\rho(Q_m,\ B^-)$, average levels of unbundled and bundled capital price ($E(p^u)$, $E(p^b)$[38]), and correlation of unbundled price with total output $\rho(p^u,Y)$ and with market valuation $\rho(Q_m,\ B^-)$. Once I have these estimates, I calibrate the model untill the final convergence of the LOMs for both aggregate capital and unbundled capital prices. Details of the solution method are provided in the Online Appendix.

III. Results

This section presents the results of quantitative experiments using the calibrated model. As Table IX shows, the model closely reproduces the empirical patterns observed in the data: (1) countercyclical sales of unbundled capital, which is highly correlated with dispersion in productivity changes among firms in the economy; (2) procyclical bundled sales (as well as acquisitions),

[37] Using multifactor productivity data from the Bureau of Labor Statistics (BLS), I calculate productivity growth dispersion as the standard deviation of productivity(%chg) across all industries. I calculate the boom-bust ratio of this dispersion as the mean dispersion during the boom to that during the bust, where boom is classified as periods with positive cyclical GDP and bust otherwise. The ratio is 0.8798 using dispersion across 3-digit SIC industries and 0.8255 using 4-digit industries.

[38] p^b is calculated as the book-value-weighted average price of bundled capital across all deals in each period.

which is highly correlated with market valuation. The model also helps rationalize the distinct resale price levels in the two markets.

[Place Table IX about here]

Aside from the main (matched) moments, the model also produces predictions on other interesting statistics. For example, in this economy, 91.46% of unbundled deals involve a more productive buyer than seller, whereas only 46.68% of bundled transactions involve a productive buyer. Taken together, buyers are more productive than sellers (or at least equally productive) in 62.4% of all transactions (value weighted). To put this number into perspective, Maksimovic and Phillips (2001) document that buyers' plants are more productive than the acquired plants in 57.2% to 59.6% of capital transactions in their sample.

The following sections present simulation results concerning the corporate asset reallocation markets: characteristics of the buyers and sellers, the corresponding reallocation efficiency, aggregate reallocation dynamics, and aggregate TFP in the economy.

A. Who buys/sells capital?

[Place Figure 2 about here]

This section examines the characteristics of buyers and sellers in both markets. Figure 2 shows the average TFP and Tobin's Q of buyers and sellers in the bundled market 5 years around the reallocation, using both simulated and empirical data. As can be seen from both the model and the data, despite having a higher valuation (Q), buyers overall have comparable or even lower productivity than sellers in the years leading up to the transaction; the gap in productivity is greater during normal periods than in high-sentiment periods, and it tends to die down in the following years. By contrast, Figure 3 shows that buyers in the unbundled market are much more productive than sellers and also have higher Tobin's Q in the two years leading up to the transaction.

[Place Figure 3 about here]

These patterns may appear puzzling when interpreted under typical neoclassical frameworks with homogeneous capital. However, a simple deviation from that assumption as in this model goes a long way toward rationalizing these facts: bundled capital, once acquired, can potentially

alter the current idiosyncratic state of the firm and thus its future path of idiosyncratic shocks. As a result of this deviation, ceteris paribus, bundled capital is an inferior substitute for unbundled capital for firms that plan to take advantage of positive productivity shocks. By contrast, it is an attractive alternative for unproductive firms that can benefit from potential TFP changes (e.g., synergy) following bundled acquisitions. This difference in capital preference is greater during economic downturns when the costs (benefits) of staying unproductive (productive) are higher, which is manifested by the greater gap in average productivity between the sellers and the buyers.

The fact that Tobin's Q and average TFP convey inconsistent signals relates to the second feature of the model: valuation sentiment can distort reallocation decisions and asset prices for popular firms. For these firms, such distortions not only reduce capital adjustment frictions but also render capital trading lucrative, even when there are no productivity gains. They enjoy higher valuations than otherwise similar firms and are more likely to engage in productivity-diminishing transactions at the expense of external investors—e.g., overinvestment in unproductive business, early liquidation of productive assets, etc. As a result, buyers in the bundled market overall exhibit much higher valuations but average productivity that is comparable to or even lower than sellers'. These patterns of relative productivity and valuation are mostly consistent with empirical observations, as shown in the right panel of Figure 2.[39]

By contrast, in the unbundled market, buyers are significantly more productive than sellers and also have higher valuations prior to the transaction. This contrast is largely due to the selection of buyers across the two markets: the potential risk associated with acquisition renders the unbundled market more attractive for marginal buyers with good idiosyncratic shocks, whereas the potential benefits from acquisition-related synergy attract marginal buyers with low idiosyncratic productivity to the bundled market. This selection is more severe during downturns when costs (benefits) from structural changes are higher for productive (less productive) marginal buyers. Since most firms (especially the ones selected into the unbundled market) are not subject to valuation distortions,[40] reallocation in this market is mostly driven by dispersion in productivity.

In the bundled market, productivity shocks still play a role, but a less prominent one: prior to

[39] An interesting deviation relates to the persistent gap in Q between buyers and sellers for transactions that occurred during normal periods in the data. This could be due to growth options or other factors that the model fails to incorporate.

[40] Based on the estimation, only 7.6% of firms have sentiment-sensitive equity valuation during normal times.

the deal, buyers on average experience improvement in productivity relative to sellers who typically experience productivity declines; but this relative improvement is much smaller than in the unbundled market. In addition to the weakened role of productivity, equity value distortions provide strong incentives for firms that are able to exploit this distortion by trading bundled assets. As a result, equity valuation turns out to be an important driving factor of reallocation in this market.

B. Dynamics of resale price and aggregate reallocation

I now describe the dynamics of aggregate reallocation in the calibrated economy and compare it with that in an economy without a bundled capital market (under the neoclassical framework). Figure 4 plots reallocation as well as price dynamics from both simulated data and real data.

[Place Figure 4 about here]

Let me start with the characteristics of an economy from a neoclassical investment model (Alternative model) with homogeneous capital and endogenized price, as shown in the second panel of Figure 4. The capital resale price in such an economy is highly procyclical. Similar to the model in Lanteri (2018), such an adverse price impact from aggregate shocks renders divestment more costly during recessions, and uncertainty about future idiosyncratic shocks dampens marginal buyers' incentive to load up on capital, both of which depress reallocation needs in downturns.

Unlike the Alternative model, in which the adverse price impact is so great that unbundled sales turn procyclical, unbundled reallocation is countercyclical in my model because the marginal benefits from reallocation are greater than the marginal costs from the adverse price impact. There are two main reasons for this discrepancy; both relate to the cross-market interactions of reallocation between the unbundled and bundled market. First, the adverse price impact from aggregate shocks is less severe in my model than in the Alternative model. Second, benefits from reallocation are greater in my model than in the Alternative model. I explain both in the following paragraphs.

Resale price is extremely sensitive to aggregate shocks in the Alternative model because firms only reallocate for productivity gains in response to shocks: good shocks induce most firms to buy, driving up asset prices and vice versa. The existence of a bundled market provides firms with new yet realistic alternatives—e.g., when hit by good aggregate shocks, rather than all rushing to buy

unbundled assets, firms can also acquire bundled assets for either real synergies or perceived synergies by marginal investors, or both. With a price less sensitive to aggregate shocks, the bundled market serves as a "cushion" for large reallocation imbalances caused by aggregate productivity changes.[41] In addition, as I will explain in Section III.C, reallocation distortions in the bundled market create hidden capital liquidity that can be activated in the unbundled market during periods of large price swings. These cross-market interactions help alleviate the adverse impact of aggregate shocks on prices and thus on reallocation. As shown in Figure 5, prices shoot up by less following good aggregate shocks (10%, compared with 15.3% in the Alternative model). Similar patterns of alleviated price impact can be observed for bad shocks; the magnitude is much smaller, though, mainly because marginal sellers are less willing to wait for disposition in the bundled market due to higher costs of holding unproductive capital.[42]

[Place Figure 5 about here]

In comparison with the Alternative model, benefits of reallocation are greater in my model as shown by the higher dispersion in marginal products upon adverse shocks in Figure 6. In the Alternative model, capital adjustment cost is the only cause of gaps in marginal products. In my model, by contrast, a major contributing factor to such gaps is distorted incentives from high valuations in the bundled market. Here is how: an extremely favorable financing environment attracts popular firms to excessive capital investment at the expense of productivity. Such distortions can persist during booms because, rather than selling excess capital in the unbundled market, these firms are willing to delay disposition in the expectation of extremely favorable asset prices in the bundled market. Once the economy turns sour, they end up with large amounts of assets that are too costly for most firms to carry as sentiment cools down. The opposite holds for firms lured into excessive divestment during a boom: most find it optimal to acquire unbundled assets during downturns when the price is low. On top of that, with weakened price impact of aggregate shocks (mentioned above), firms are less willing to wait for price improvement in the unbundled market as they would in the Alternative model. As a result, unbundled reallocation spikes following bad shocks, as shown in Figure 5.

[41] Eg., following good aggregate shocks, certain firms may find it optimal to switch to the bundled market for capital needs as price of unbundled capital continues to rise.

[42] Idiosyncratic shocks are more persistent during bad times.

[Place Figure 6 about here]

In the bundled market, on the other hand, reallocation is procyclical. This is because, unlike its unbundled counterpart, bundled capital comes with its own technology, which may or may not complement that of its new owner. Such uncertainty renders the asset an inferior substitute for unbundled capital for firms who want to take advantage of good productivity shocks. As a result, productivity dispersion is less of an incentive for reallocation in the bundled market. On top of that, following consecutive good aggregate shocks, more firms find themselves in a favorable capital environment to either expand—even excessively—or cash in a portion of their business, which results in a higher level of reallocation activity. Although profitable, these transactions are not necessarily efficient for productivity—e.g., participants in this market tend to be overly active in capital trading that features frequent overinvestment and divestment. In the model, excessive capital trading is fueled by high sentiment surrounding popular firms. The dot-com bubble in the late 1990s, featuring over-eager investors willing to invest at any valuation on internet-related companies, is an example of sentiment that helped power the then red-hot M&A market.

The fact that valuation sentiment can lead to opportunistic trading, however, does not suggest that bundled reallocation is purely a financial game that creates no value. Most firms (92.4% during normal times and 62.4% when sentiment is high) still make acquisition/divestiture decisions purely for productivity reasons, as they do in the unbundled market.[43] In addition, as I show below, such sentiment also has its bright side in facilitating efficient reallocation in the unbundled market. However, the evidence does underline the importance of market sentiment in shaping the cyclical dynamics of bundled reallocation.

C. Reallocation efficiency and aggregate productivity

So far I have focused primarily on firms' TFP. However, with decreasing returns to scale (DRS), reallocation efficiency is determined by the marginal product of capital (MPK), rather than the TFP of firms. In a frictionless economy with DRS technology, firms with different TFP can co-exist. Reallocation of capital from low-MPK to high-MPK firms improves aggregate productivity,

[43] E.g., Figure 8 compares marginal products of normal and popular buyers/sellers in both markets. As can be seen, for normal firms, reallocation decisions in both markets are similar in the sense that firms with higher MPK expands till its marginal product approaches marginal cost of capital.

which is optimized once the marginal products of all firms are equalized. With frictions (physical or financial), capital adjustment is not complete, and the gaps in MPK between marginal capital buyers and sellers reflect the magnitude of such frictions.

[Place Figure 7 about here]

As Figure 7 shows, reallocation in the unbundled capital is efficient in the sense that firms with greater (smaller) MPK expand (downsize) until the gap between the two converges (incompletely). Reallocation in the bundled market, however, is not as efficient as a result of excessive capital trading by firms with distorted valuations. Backed by an extremely favorable capital environment, these firms tend to either overinvest or overdivest. Unlike buyers in the unbundled market who acquire capital until its marginal product approaches the marginal cost, bundled capital buyers tend to "overshoot," which drives its marginal product below the marginal cost. Such a tendency toward excessive but inefficient reallocation during high-sentiment times has been well documented in the merger wave literature; for example, Porter (1989) and Kaplan and Weisbach (1992) report that 44% to 60% of unrelated acquisitions made during the conglomerate merger wave in the 1960s were subsequently divested. Additionally, Ravenscraft and Scherer (1987) find that the profitability of acquired firms did not improve, on average.

[Place Figure 8 about here]

Valuation sentiment in such an economy has two offsetting effects on aggregate TFP: (1) spurring excessive opportunistic trading of capital in the bundled market; (2) easing frictions to reallocation, thus facilitating efficient reallocation in the unbundled market. The first effect is straightforward, and Figure 8 visualizes the tendency of popular firms to engage in aggressive expansions or contractions. In practice, excessive capital trading is not unusual. As Kaplan and Weisbach (1992) put it, "acquirers often buy other companies only to sell them afterward"; they find that prices obtained in such divestitures are high enough to justify the acquisitions ex ante.[44] The second effect comes from the interaction of reallocation across these two markets: sentiment that motivated overinvestment or overdivestment in the bundled market helps enhance capital liquidity in the unbundled market. In an economy without the bundled market, capital resale price is so sensitive to aggregate

[44] For deals with comparable sale prices, they find that targets are sold at 143% of their market value before the initial takeover announcement.

shocks that firms would postpone dispositions in downturns untill the economy recovers. In the calibrated economy, such an effect is less severe thanks to the hidden liquidity from firms that previously overinvested or overdivested in the bundled market. For instance, following good aggregate shocks, firms previously overinvested in the bundled market would be enticed to sell their extra capital in the unbundled market as the unbundled capital price continues to rise.[45] Such hidden liquidity helps counteract the adverse price impact of aggregate shocks, and thus facilitates efficient capital reallocation. Figure 5 visualizes this effect. Compared to an economy with only unbundled capital, the resale price responses less to aggregate shocks. In addition, rather than delaying asset dispositions, firms reallocate more during economic downturns.

In the model, two important variables help quantify these two offsetting effects: the magnitude of overvaluation B and the level of real asset price inflation p_s^b. B captures the extent to which (irrational) marginal investors overvalue the benefits of certain acquisitions, as a percentage of the capital acquired. On the other hand, p_s^b captures the level of the bundled capital price supported by such market euphoria. In the extreme (unrealistic) case where the impact of equity misvaluation is confined to the financial market—it has no effect on real asset prices, and acquirers pocket all financial gains, moderate overvaluation eases reallocation frictions without encouraging excessive trading, because the incentive to overinvest is dampened by the expected cost of unloading capital in the future. At the other extreme, where equity misvaluation is fully incorporated into real asset prices—e.g., targets pocket all gains, greater overvaluation encourages more inefficient reallocation because the optimal strategy for corporate managers is to trade their assets like securities—as brokerage firms would do. Figure 9 plots the marginal impact of B and p_s^b on the aggregate TFP in the calibrated economy.

[Place Figure 9 about here]

In practice, the typical case would be somewhere in between. In the calibrated economy, 56.3% of the financial benefits from valuation distortions can be attributed to the acquirer, and the remaining 43.7% $((p_s^b - p_n^b)/B)$ to the target. In the net, the counterproductive effect of sentiment dominates, resulting in a moderate loss in TFP. Counterfactual analysis shows that aggregate TFP in the calibrated economy is 1.4% lower than in the economy under the Alternative model.

[45] E.g, for popular firms, although pricing in the bundled market is extremely attractive, some will still be willing to sell unbundled at relatively lower prices because bundled transactions only succeed with certain probability.

IV. Conclusion

In this paper I present new evidence on the nature of capital reallocation in two distinct used-capital markets. In so doing, I introduce a new perspective to the literature regarding the causes and consequences of procyclical capital reallocation. In the data, reallocation of unbundled capital is countercyclical, and more importantly, it is highly correlated with dispersion in TFP growth, both within and across industries. On the other hand, bundled capital reallocation is procyclical, highly correlated with equity market valuation, and bears no consistent relation to productivity dispersion measures. In addition, the price of unbundled capital is highly sensitive to aggregate productivity shocks consistent with a demand/supply-driven market in response to productivity shocks. The bundled capital price, however, is insensitive to such shocks and exhibits features that resemble that of an acquisition market driven by equity market valuation.

The evidence suggests that, in the unbundled market where capital serves as a homogeneous factor of production, firms indeed reallocate more when the benefits—e.g., dispersion in TFP growth—are greater. The market for bundled capital, however, exhibits features that are hard to rationalize without a proper understanding of the nature of bundled capital. Unlike its unbundled counterpart, which inherits the productivity of its new owner, bundled capital typically comes with its own production technology, which may or may not complement that of its buyer. Such uncertainty discourages reallocation needs motivated by productivity gains in the bundled market. In addition, owing to the uniqueness of each individual unit, bundled capital is typically hard to value and prone to misvaluation. The latter opens the door to opportunistic trading, which manifest itself in the proliferation of capital transactions during periods of high market valuation.

I show that a heterogeneous agent model of investment with segmented used capital markets and a valuation sentiment component generates predictions consistent with evidence observed in both markets. The model generates procyclical resale prices; however, reallocation in the unbundled market is countercyclical because the benefits from reallocation outweigh the adverse price impact of adverse shocks in economic downturns. Bundled capital sales, by contrast, are procyclical because, following consecutive good aggregate shocks, more firms find themselves in an extremely

favorable equity market to either expand or downsize aggressively.

Equity overvaluation eases capital adjustment frictions, facilitating efficient asset reallocation, while also encouraging opportunistic capital trading featuring frequent overinvestment and overdivestment. Its net impact on aggregate TFP relies on the extent to which financial is transmitted to real asset prices. In the counterfactual exercise, I show that aggregate TFP of the calibrated economy is 1.4% lower than that of an economy under standard neoclassical assumptions.

REFERENCES

Ai, Hengjie, Kai Li, and Fang Yang, 2019, Financial intermediation and capital reallocation, *Journal of Financial Economics, Forthcoming* .

Baker, Malcolm, Xin Pan, and Jeffrey Wurgler, 2012, The effect of reference point prices on mergers and acquisitions, *Journal of Financial Economics* 106, 49–71.

Barberis, Nicholas, Andrei Shleifer, and Robert Vishny, 1998, A model of investor sentiment, *Journal of Financial Economics* 49, 307 – 343.

Bouwman, Christa H. S., Kathleen Fuller, and Amrita S. Nain, 2007, Market Valuation and Acquisition Quality: Empirical Evidence, *The Review of Financial Studies* 22, 633–679.

CKermani, Amir, and Yueran Ma, 2020, Asset specificity of non-financial firms, *NBER Working Paper* .

Cooper, Russell W., and John C. Haltiwanger, 2006, On the Nature of Capital Adjustment Costs, *The Review of Economic Studies* 73, 611–633.

Donaldson, Jason Roderick, Denis Gromb, and Giorgia Piacentino, 2021, Collateral reallocation, *Working Paper* .

Dong, Ming, David Hirshleifer, Scott Richardson, and Siew Hong Teoh, 2006, Does investor misvaluation drive the takeover market?, *The Journal of Finance* 61, 725–762.

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

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

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

Gomes, Joao F., 2001, Financing investment, *American Economic Review* 91, 1263–1285.

Hamilton, James D., 2018, Why you should never use the hodrick-prescott filter, *The Review of Economics and Statistics* 100 (5), 831–843.

Hodrick, Robert J, 2020, An exploration of trend-cycle decomposition methodologies in simulated data, Working Paper 26750, National Bureau of Economic Research.

Kaplan, Steven N., and Michael S. Weisbach, 1992, The success of acquisitions: Evidence from divestitures, *The Journal of Finance* 47, 107–138.

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

Krusell, Per, and Anthony A. Smith, 1997, Income and wealth heterogeneity, portfolio choice, and equilibrium asset returns, *Macroeconomic Dynamics* 1 (2), 387–422.

Lanteri, Andrea, 2018, The market for used capital: Endogenous irreversibility and reallocation over the business cycle, *American Economic Review* 108 (9), 2383–2419.

Lanteri, Andrea, and Adriano A. Rampini, 2021, Constrained-efficient capital reallocation, *NBER Working Paper No. w28384, Available at SSRN: https://ssrn.com/abstract=3772623* .

Li, Shaojin, and Toni M. Whited, 2015, Capital reallocation and adverse selection, *Unpublished working paper* .

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

Matsusaka, John G., 1993, Takeover motives during the conglomerate merger wave, *The RAND Journal of Economics* 24, 357–379.

Matthew Rhodes–Kropf, David T. Robinson, and S. Viswanathan, 2005, Valuation waves and merger activity: The empirical evidence, *Journal of Financial Economics* 77, 561–603.

Morck, Randall, Andrei Shleifer, and Robert W. Vishny, 1990, Do managerial objectives drive bad acquisitions?, *The Journal of Finance* 45, 31–48.

Nelson, Ralph L., 1959, *Merger Movements in American Industry, 1895-1956* (National Bureau of Economic Research, Inc).

Porter, Michael E., 1989, *From Competitive Advantage to Corporate Strategy* (Macmillan Education UK, London).

Ravenscraft, David J., and F. M. Scherer, 1987, *Mergers, Sell-Offs, and Economic Efficiency* (Brookings Institution Press).

Rhodes-Kropf, Matthew, and S. Viswanathan, 2004, Market valuation and merger waves, *The Journal of Finance* 59, 2685–2718.

Savor, Pavel G., and Qi Lu, 2009, Do stock mergers create value for acquirers?, *The Journal of Finance* 64, 1061–1097.

Shleifer, Andrei, and Robert W. Vishny, 2003, Stock market driven acquisitions, *Journal of Financial Economics* 70, 295 – 311.

Yang, Liu, 2008, The real determinants of asset sales, *The Journal of Finance* 63, 2231–2262.

Table I

Levels and Dynamics of Capital Resale Prices. Panel A presents selected (cross-section) percentiles as well as averages of resale prices for both unbundled and bundled capital respectively. For each year, resale prices are first aggregated at the firm level (ratio of total sales proceeds to book value of the capital sold) for both types of capital. I compute the percentiles of capital prices across all firms using three alternative weighting strategies: book-value weights (Bval); transaction value weights (Tval) or unit weights(S.A). Average prices are computed similarly for each year, e.g, book value weighted average prices use book value of capital sold as weights, whereas unit weighted average prices are simple averages. I then compute the time series averages of these statistics: columns "$P1 - P99$" denote time-series averages of the percentiles/averages across all sample periods. Panel B show correlations with GDP. Log GDP data is stationalized using either Hamilton filter or First-Difference before estimation of cyclical correlations. In Panel B, the time series of aggregate capital price is constructed using book value of capital sold as weights. Sample periods: 1995-2017.

Panel A: Summary Statistics of Capital Resale Prices

		Percentiles					Mean
weights		$P1$	$P25$	$P50$	$P75$	$P99$	
Bval	Un-	0.156	0.787	0.967	1.140	2.533	1.015
Tval	bundled	0.360	0.928	1.186	1.598	5.606	1.394
S.A		0.019	0.562	0.948	1.329	10.030	1.221
Bval	Bundled	0.297	0.914	1.165	1.595	4.282	1.375
Tval		0.566	1.102	1.519	2.284	21.559	2.936
S.A		0.162	0.933	1.261	2.019	44.743	2.427

Panel B : Correlation of Output with Capital Resale Prices

	Log GDP, filtered by			
	Hamilton		First-Difference	
corr with	Unbundled	Bundled	Unbundled	Bundled
Resale Price	0.552	0.155	0.594	0.092
	(0.343)	(0.297)	(0.304)	(0.321)

* Price data are winsorized at 1% by year to alleviate impact of outliers.

Table II

Correlations of Capital Resale Prices with Sentiment. Correlations calculated for both the averages as well as selected percentiles. Time series of aggregate resale price constructed using book value of capital sold as weights. Sentiment data from professor Jeffrey Wurgler's website. To alleviate the impact of aggregate economic conditions, the index $SENT^{\perp}$ is used instead of $SENT$. Panel A reports raw correlation estimates and panel B reports regression coefficients of prices on sentiment after controlling for log GDP growth. Sample periods: 1995-2017.

A: Correlation of Sentiment with Capital Resale Prices

	Percentiles					
corr with	$P5$	$P25$	$P50$	$P75$	$P95$	Ps(mean)
	(1)	(2)	(3)	(4)	(5)	(6)
Bundled	-0.388	-0.192	-0.474	-0.112	0.414	-0.158
	(0.441)	(0.312)	(0.247)	(0.260)	(0.414)	(0.237)
Unbundled	0.450	0.392	0.429	0.412	0.154	0.422
	(0.193)	(0.177)	(0.233)	(0.260)	(0.235)	(0.224)

B: Correlation of Sentiment with Prices Controlling for Output

corr with	$P5$	$P25$	$P50$	$P75$	$P95$	Ps(mean)
	(1)	(2)	(3)	(4)	(5)	(6)
Bundled	-0.455	-0.239	-0.537	-0.146	0.428	-0.184
	(0.196)	(0.217)	(0.223)	(0.223)	(0.207)	(0.224)
Unbundled	0.389	0.304	0.332	0.301	0.058	0.310
	(0.192)	(0.185)	(0.169)	(0.166)	(0.198)	(0.167)

Table III

Cyclicality of Capital Reallocation. Panel A uses asset sales data collected from corporate 10K filings, presents correlations of total output with both quantity and value of capital reallocation (unbundled sales, bundled sales and aggregate reallocation of both). Reallocation quantity (value) is measured as the ratio of book value (transaction value) of capital sold at t to book value of total capital in stock at $t-1$. For unbundled, I use property, plant and equipment as total capital in stock. For bundled, we use asset total as total capital in stock. GDP data is stationalized using two main filters before estimation of its correlation with reallocation: the Hamilton filter and First-Difference. Panel B reports correlations of output with values of property, plant and equipment (PPE) sales and acquisitions from Compustat. PPE sales measured as the ratio: *Proceeds from sales of* PPE_t*/Book value of PPE in stock*$_{t-1}$; Acquisition measured as: *Proceeds from acquisitions*$_t$*/Book value of total assets*$_{t-1}$. Cyclical correlations for aggregate reallocation computed following existing literature (apply the HF filter on both reallocation and GDP before estimation of cyclical correlations; a smoothing parameter of 100 is used as in Eisfeldt and Rampini (2006)) are also presented in the last column of both panel. Sample periods: 1995-2017.

Panel A: Correlations of Capital Sales Turnover with Output

	GDP, filtered by						
	Hamilton			First-Difference			HP
corr with	Unbundled	Bundled	Aggregate	Unbundled	Bundled	Aggregate	Aggregate
Quantity	-0.403	0.372	0.125	-0.370	0.440	0.202	0.274
	(0.192)	(0.175)	(0.245)	(0.208)	(0.162)	(0.257)	(0.303)
Value	-0.038	0.463	0.349	-0.009	0.523	0.285	0.441
	(0.171)	(0.176)	(0.235)	(0.179)	(0.161)	(0.341)	(0.260)

Panel B: Correlations using Compustat Data for the Main Sample

	GDP, filtered by						
	Hamilton			First-Difference			HP
corr with	SPPE	Acquisition	Aggregate	SPPE	Acquisition	Aggregate	Aggregate
Value	0.021	0.428	0.415	0.016	0.426	0.417	0.594
	(0.247)	(0.235)	(0.244)	(0.249)	(0.254)	(0.261)	(0.169)

Table IV

How Reallocation Relates to Dispersion in Productivity Growth and Q. Panel A reports correlations between reallocation and measures of dispersion in multifactor productivity growth, both across industries and within industry. Dispersion in productivity growth measured three alternative ways: a.standard deviation; b.difference between the top and bottom quartiles; c.difference between the top and bottom percentiles. For cross-industry measures, I use the series "multifactor productivity (percent change)" provided by Bureau of Labor Statistics (BLS) at the 4 digit naics level from 1995-2017. For within-industry measures, I use the activity weighted within-industry productivity dispersion (measured at naics 4 digit industry level) from Dispersion Statistics on Productivity, an experimental product jointly developed & published by the BLS and the Census Bureau (data available from 1997-2016). For all measure, I use value of production as weights in aggregation (averages, percentiles, etc). Panel B reports correlations between reallocation with dispersion in Q across all non-finance/utility firms in Compustat. Dispersion in Q measured as either the standard deviation or the difference between top and bottom quartiles, all computed using lag market capitalization as weights.

Panel A: Correlation of Capital Sales with Dispersion in Productivity (Growth)

	Cross-Industry Dispersion			Within-Industry Dispersion		
corr with	s.d	q3-q1	p90-p10	s.d	q3-q1	p90-p10
Unbundled	0.382	0.131	0.572	0.285	0.396	0.414
	(0.159)	(0.201)	(0.318)	(0.278)	(0.289)	(0.238)
Bundled	0.501	-0.473	-0.040	-0.243	0.146	-0.108
	(0.289)	(0.265)	(0.315)	(0.377)	(0.529)	(0.466)

Panel B: Correlation of Capital Sales with Dispersion in Q

	Unbundled			Bundled		
corr with	$s.d(Q)^{***}$	$s.d(Q<5)$	Q(q3-q1)	$s.d(Q)$	$s.d(Q<5)$	Q(q3-q1)
	0.028	-0.052	-0.023	0.378	0.437	0.260
	(0.196)	(0.308)	(0.198)	(0.171)	(0.299)	(0.234)

Table V

How Reallocation Relates to Sentiment. Table presents correlations between reallocation and proxies of valuation sentiment. Reallocation measured as ratio of book value of capital sold to book value of total capital in stock. For unbundled, I use property, plant and equipment as total capital in stock. For bundled, we use asset total as total capital in stock. Columns (1)-(2) use percentage of firms with a Q greater than 1 or 3 as proxies for valuation sentiment. Columns (3)-(5) use the 25th, 50th or 75th percentile of Q. Columns (6)-(7) use average level of Q of firms with Q smaller than 2 or 10. Column (8) use the sentiment index from professor Jeffrey Wurgler's website.

	% of firms		***Percentile.Q***			***Average Q***		***Sentiment***
corr with	$Q > 1$	$Q > 3$	$P25$	$P50$	$P75$	$Q < 2$	$Q < 10$	SENT
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Unbundled	0.05	-0.05	0.03	-0.04	-0.01	0.03	-0.03	0.21
	(0.31)	(0.23)	(0.23)	(0.22)	(0.17)	(0.37)	(0.23)	(0.17)
Bundled	0.47	0.49	0.48	0.42	0.33	0.52	0.54	0.41
	(0.24)	(0.24)	(0.23)	(0.22)	(0.20)	(0.20)	(0.24)	(0.14)

Table VI

Potential Drivers of Bundled Capital Sales. This table presents coefficients from regression of bundled capital reallocation on dispersion in Tobin's Q as well as proxies of valuation sentiment. Dispersion in Q is measured as the standard deviation of Tobin's Q across all firms in the CCM universe. There are two alternative proxies for valuation sentiment: average Q for firms with Q less or equal 10, sentiment index "SENT" from Jeffrey Wurgler's website. Regression results for different specification are reported in column (1)- column (5), column(4)-column(5) controls for the impact of productivity growth dispersion. All variables are standardized before regression.

	Bundled capital sales				
	(1)	(2)	(3)	(4)	(5)
$Std.Dev(Q)$	0.38*	-0.29	0.24	-0.35	0.10
	(0.20)	(0.35)	(0.22)	(0.32)	(0.21)
$AvgQ(q <= 10)$		0.79**		0.72**	
		(0.35)		(0.32)	
SENT			0.30		0.33
			(0.22)		(0.20)
Control for Std.Dev(TFP)	NO	NO	NO	YES	YES
R^2	0.143	0.317	0.215	0.457	0.396

Table VII

Characteristics of Capital Reallocation for Private Firms. This table uses capital sales data of private companies from Capital IQ from 2012 to 2019. Panel A estimates correlations of output with both sales of PP&E (SPPE) and divestitures. I measure reallocation value (quantity) as the ratio of proceeds from (book value of) capital sold at time t to total book value of capital in stock at $t-1$. For property, plants and equipment, book value is computed as "$SPPE$"-/+ "gain/loss on sales of asset", I use net property, plants and equipment in stock as denominator. For divestiture and cash acquisitions, I use total asset as denominator. Two alternative filters are used to stationalize GDP before correlation estimation: Hamilton filter and First-Difference. Panel B presents correlations of capital sales with productivity dispersion measured as either the standard deviation of TFP growth across industries, or the difference between the top and bottom quartiles(q3-q1) or deciles (p90-p10). Panel C estimates the correlation of cash acquisition with GDP and Panel D presents correlations of capital reallocation measures with proxies market sentiment, including equity market value based proxies and the sentiment index from professor Jeffrey Wurgler's website.

Panel A: Correlation of Output with Capital Sales

corr with	Log GDP, filtered by			
	Hamilton		First-Difference	
	$SPPE$	$Divest$	$SPPE$	$Divest$
Value	-0.299	0.576	-0.198	0.598
	(0.382)	(0.314)	(0.377)	(0.284)
Quantity	-0.328		-0.223	
	(0.365)		(0.386)	

B: Correlation of Dispersion in TFP Growth with Capital Sales

	SPPE			Divest		
	s.d	q3-q1	p90-p10	s.d	q3-q1	p90-p10
Value	0.804	0.611	0.461	0.158	0.493	0.243
	(0.220)	(0.460)	(0.339)	(0.384)	(0.179)	(0.429)

C: Correlation of Output with Cash Acquisition

	Log GDP, filtered by	
	Hamilton	First-Difference
Value	-0.367	-0.191
	(0.476)	(0.474)

D: Correlation with Sentiment Proxies

	$\%(Q>1)$	$\%(Q>3)$	$\%(Q>5)$	Avg Q(≤ 5)	Avg Q(≤ 10)	SENT
SPPE	-0.172	-0.437	-0.620	-0.428	-0.477	-0.416
	(0.810)	(0.394)	(0.464)	(0.458)	(0.492)	(0.456)
Divest	-0.703	-0.149	-0.112	-0.306	-0.255	-0.160
	(0.099)	(0.402)	(0.514)	(0.293)	(0.348)	(0.349)
Cash	-0.338	-0.788	-0.885	-0.746	-0.760	0.088
Acquisition	(0.557)	(0.170)	(0.103)	(0.212)	(0.210)	(0.618)

Table VIII

This table reports the choices of parameter value in the model.

Adopted:		
α	output elasticity of capital	0.592
β	discount factor	0.930
ρ_a	AR1 coeff for aggregate shock	0.750
σ_a	Std Dev of aggregate shock innovation	0.050
ρ_i^H	AR1 coeff for idiosyncratic shock (high aggregate productivity)	0.550
ρ_i^L	AR1 coeff for idiosyncratic shock (low aggregate productivity)	0.900
σ_i	Std Dev of of idiosyncratic shock innovation	0.100
δ	Depreciation rate	0.100
Calibrated:		
γ	Adjustment cost (convex) for new & used unbundled capital	0.146
f_u	Adjustment cost (fixed) for unbundled capital transfer	0.015
ϕ	Adjustment cost for bundled capital (ratio to capital)	0.043
p_n^b	Price of bundled capital for normal firms	1.059
p_s^b	Price of bundled capital for firms sensitive to sentiment	1.411
P_o	Probability of deal completion (bundled capital transactions)	0.167
P_s	Probability of structural change following bundled acquisition	0.421
S_o	% of firms subject to euphoric sentiment	0.076
δ_s	Increase in S_o following consecutive good aggregate shocks	0.300
b	financing benefits of acquisition as fraction of capital acquired	0.805

Table IX

This table presents statistics on capital resale prices as well as reallocation dynamics both from data and model.

Moments to be matched:		Model	Data
Resale prices			
$E(p^u)$	average unbundled capital price	1.055	1.015
$E(p_a^b)$	average bundled capital price	1.397	1.375
$\rho(p^u, Y)$	correlation of p^u with aggregate output	0.902	0.553
$\rho(p^u, Q_m)$	correlation of p^u with market valuation	0.761	0.410
Reallocation quantities			
$E(U)$	average turnover of unbundled sales	1.266	1.220
$E(B^-)$	average turnover of bundled sales (book value)	0.591	0.730
$E(B^+)$	average turnover of bundled acquisitions (transaction value)	2.279	2.230
$\rho(U, Y)$	correlation of unbundled sales with aggregate output	-0.304	-0.403
$\rho(B^-, Y)$	correlation of bundled sales with aggregate output	0.187	0.372
$\rho(B^+, Y)$	correlation of acquisitions with aggregate output	0.565	0.428
$\rho(B^-, Q_m)$	correlation of bundled sales with market valuation	0.638	0.410
Other model implied statistics:			Model
% unbundled deals with more productive buyers than sellers			91.46%
% bundled deals with productive buyers (less productive sellers)			46.68%
Correlation of unbundled sales with dispersion in productivity change			0.402
Correlation of bundled sales with dispersion in productivity change			-0.093

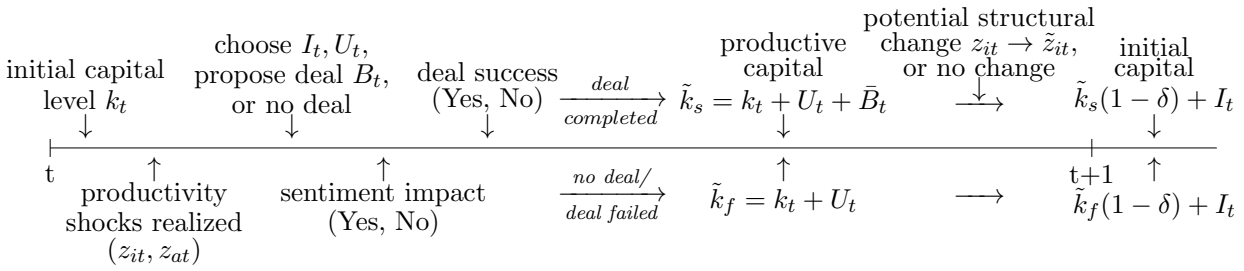

Figure 1. Time line

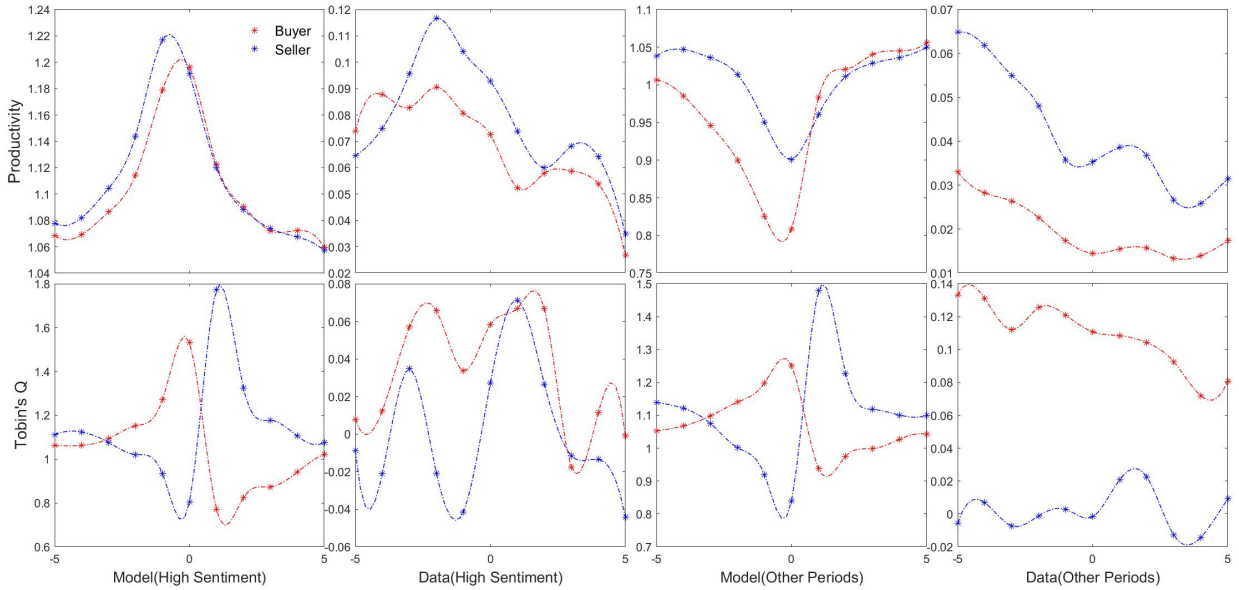

Figure 2. Characteristics of buyers and sellers in the bundled capital market. The top (bottom) panel plots average productivity and Tobin's Q of both the buyers and sellers 5 years before and after the transaction. Productivity is proxied by the gross profitability of the firm. Transactions are grouped into two categories based on whether the transaction occurred during periods of high valuation sentiment or not. The left two columns use model generated data, whereas right two columns use data on bundled capital sales and Compustat data on acquisitions and accounting performances. All empirical measures are industry demeaned at 2 digit sic level. High sentiment periods are defined as years following consecutive good aggregate productivity shocks for model implied data and years with a sentiment index half a standard deviation above historical mean (alternative definition using consecutive GDP growth half a standard deviation above historical mean results in similar but noisier patterns).

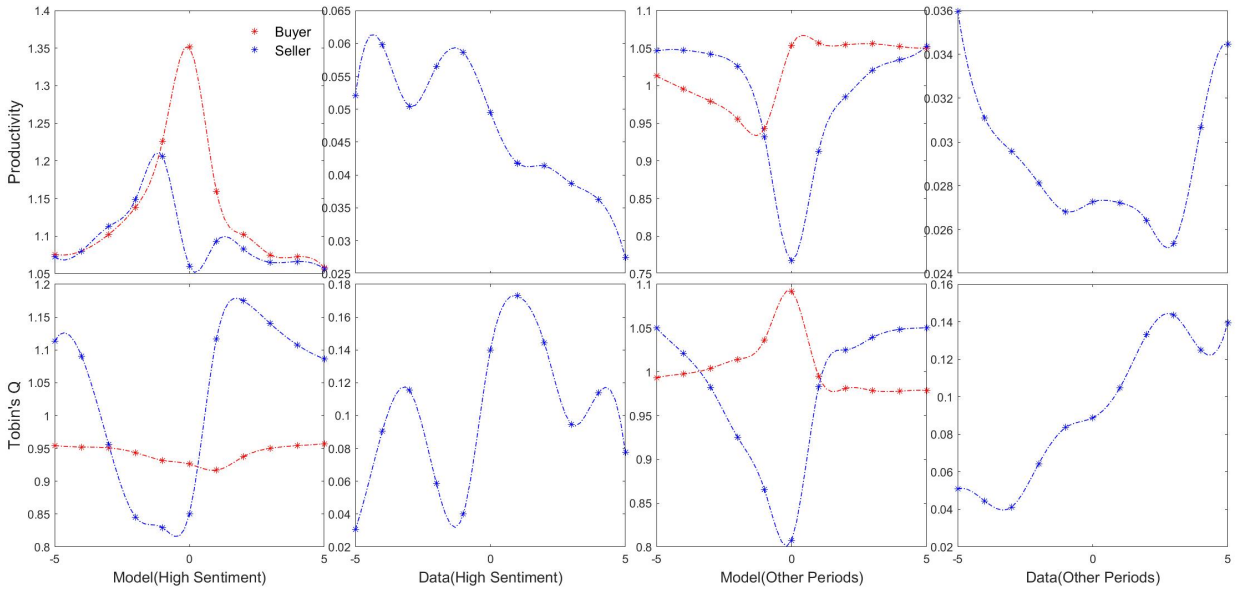

Figure 3. Characteristics of buyers and sellers in the unbundled capital market. Definitions of the series follows Figure 2. The right two columns only demonstrate accounting measures on unbundled capital sellers (data on buyers not available).

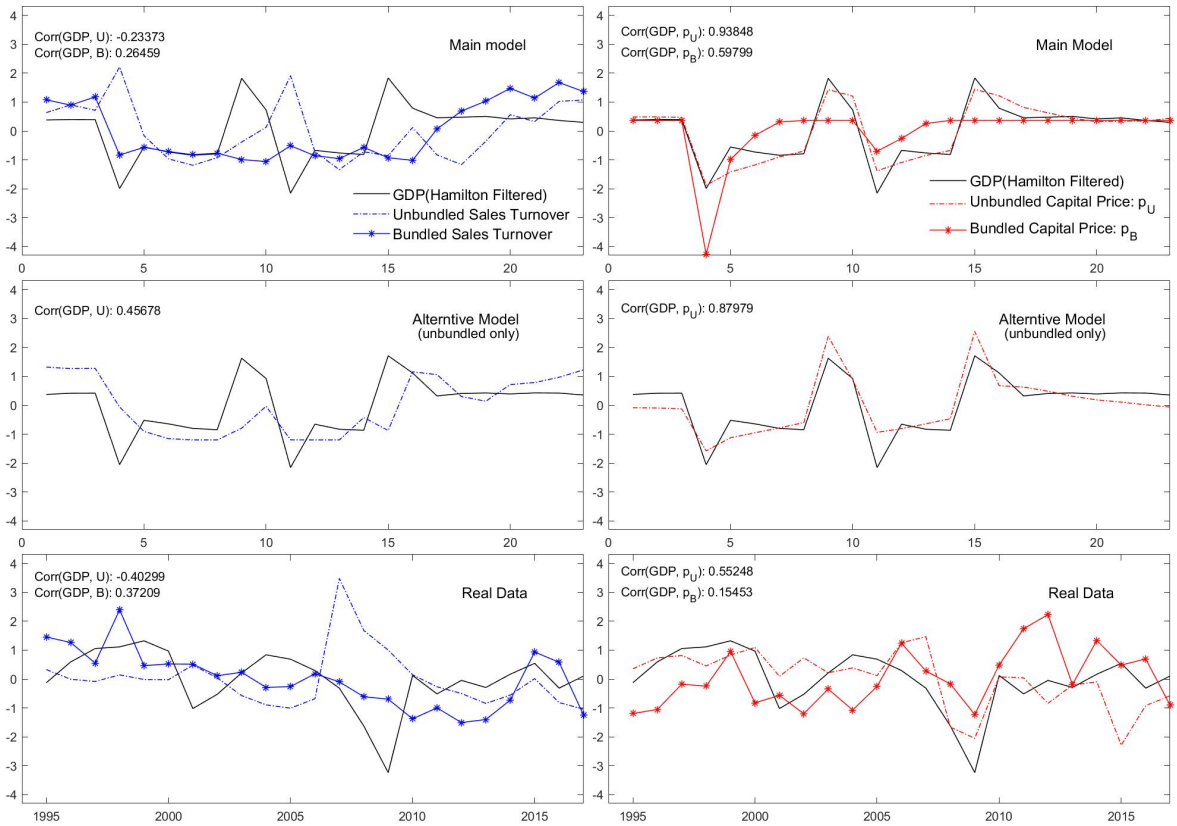

Figure 4. Aggregate reallocation (left) and asset prices (right) across business cycles. Top panel uses data generated from the main model with a random path, the following panel uses data generated from the same model excluding the bundled capital market, bottom panel presents data using GDP from U.S. Bureau of Economic Analysis and collected data on asset sales and prices.

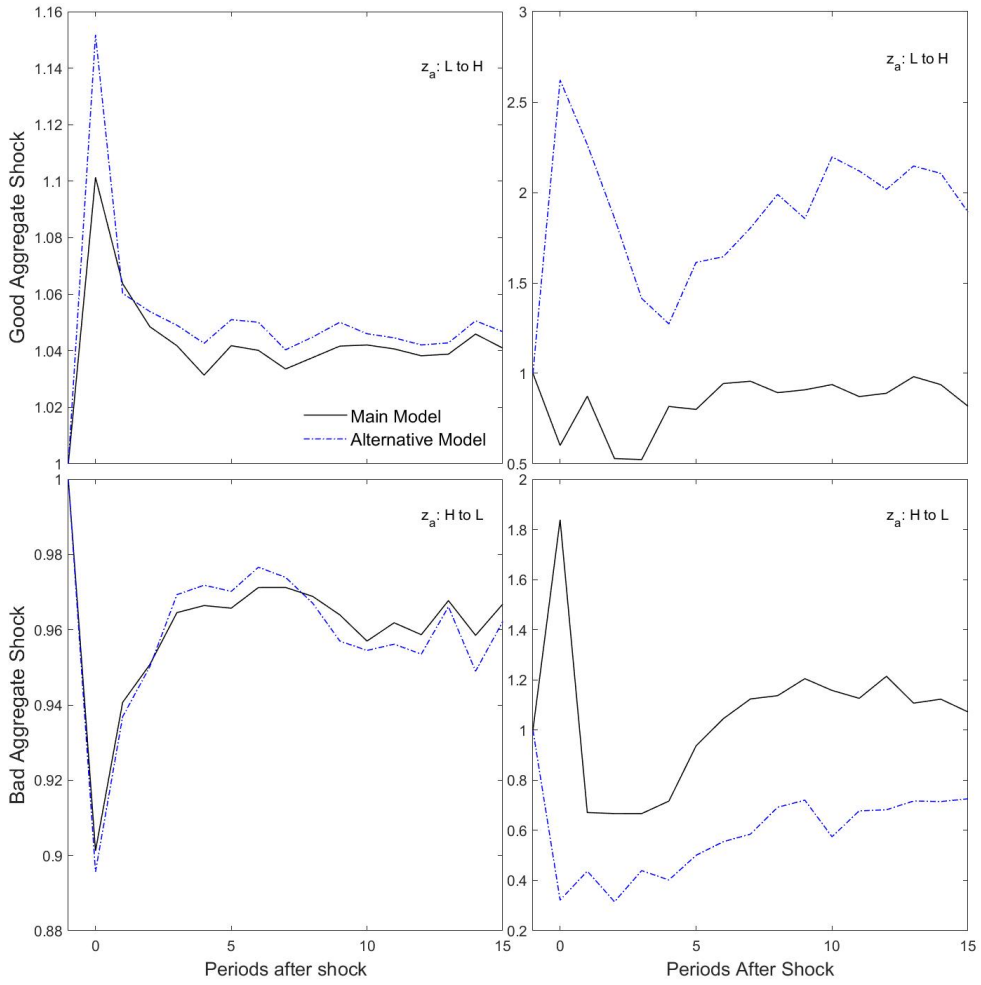

Figure 5. Unbundled capital price (left) and reallocation (right) following good (bad) aggregate shocks. Both price and reallocation normalized to 1 before the shocks. Black line demonstrate price impact as well as reallocation dynamic under the main model, whereas blue line the model with only unbundled market.

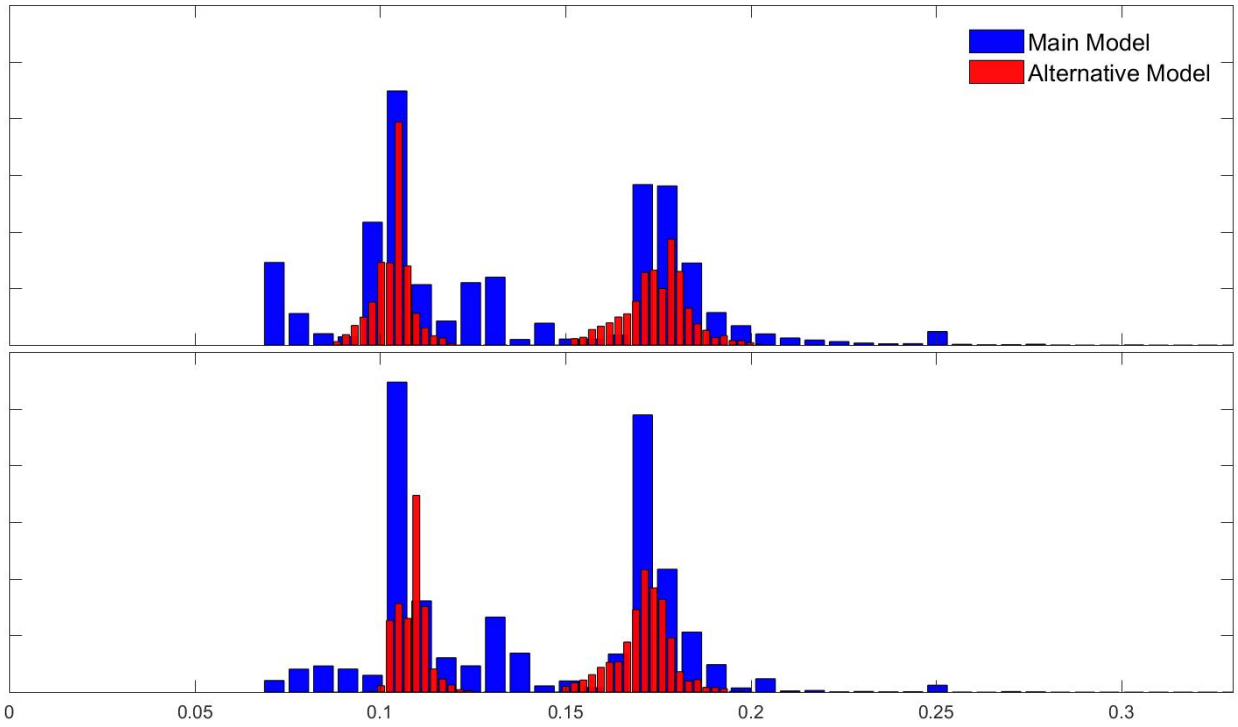

Figure 6. Distribution of MPK at the beginning (top) and end (bottom) of transitions from $z_a = H$ to $z_a = L$. Pictures show histograms, each bar's vertical height corresponds to the amount of capital with marginal product within the range marked by the edges of the bar along the x-axis. Blue bars show distribution under the main model, whereas red bar the Alternative model.

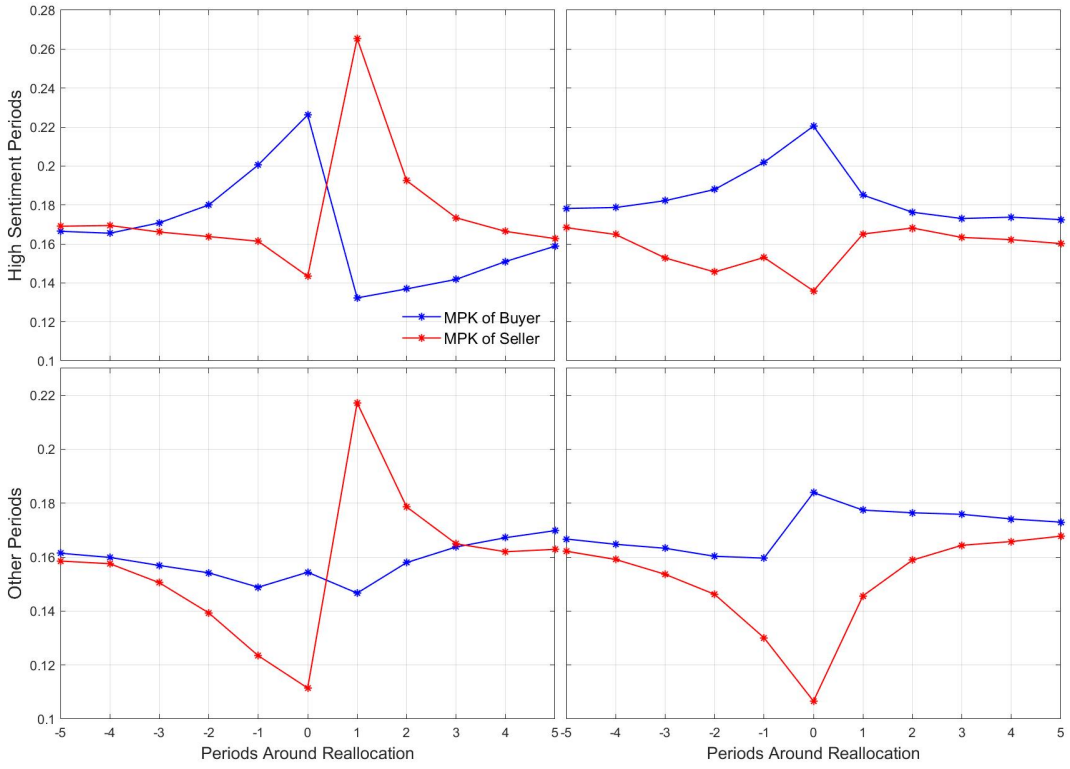

Figure 7. Marginal product of buyers/sellers in the bundled market (left) and unbundled market (right): by periods. Both price and reallocation normalized to 1 before the shocks. Black line demonstrate price impact as well as reallocation dynamic under the main model, whereas blue line the model with endogenized capital price.

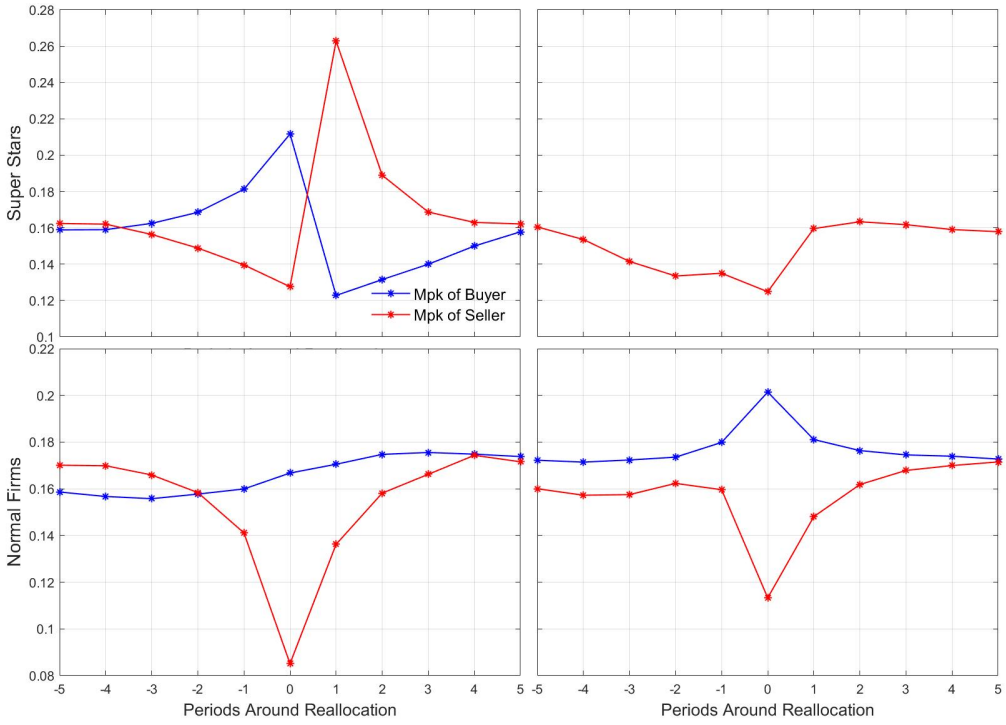

Figure 8. Marginal product of buyers/sellers in the bundled market (left) and unbundled market (right): by firm type. Mpk data averaged over all periods. Missing blue line for buyers in the unbundled market because type II firms do not acquire capital in the unbundled capital market.

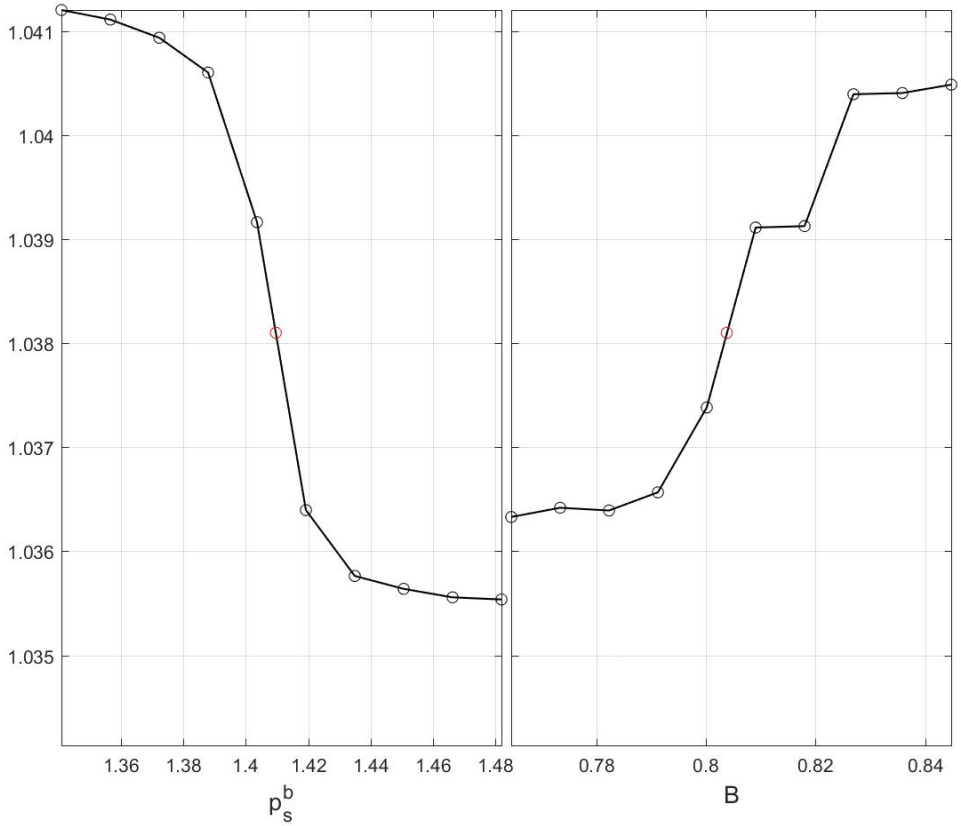

Figure 9. Marginal impact of equity valuation (B) and real asset price (p_s^b) on aggregate productivity. B captures the extent to which external (irrational) investors overvalue the benefits of certain acquisitions, as a percentage of the capital acquired. p_s^b captures the level of bundled capital price supported by such market euphoria. Red circles mark the original values of aggregate TFP, B, p_s^b from the calibrated economy. Black circles mark changes in aggregate TFP as we vary the x variable with other variables fixed.