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Why do firms purchase used assets?

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Why do Firms Purchase Used Assets?

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Abstract:

We hypothesize that the increase in expectation about future technological change decreases the likelihood for the purchase of new assets because the change may make the new assets obsolete. To test this hypothesis, we use patents and citations data to represent the expected technological change. We find that the purchases of and the amount spent on used assets increase with the expectation of technological change; while time to completion of the purchase and the number of bids decrease with the increase in expectations about technological change. We exploit industry deregulations to establish identification. In contrast to the literature, we find no empirical support for financial constraint as a reason for purchasing used assets.

Keywords: Used assets; acquisitions; technology; change

JEL Classification: G34, G30, G31

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I. INTRODUCTION

We investigate whether the purchase of used assets is more likely when an industry is undergoing significant technological change. A used asset is an asset that one firm divests and another purchases. Between 1980 and 2013, firms traded $3.1 trillion worth of used assets, reflecting the significance of this market. In this strand of the literature, the key reason why firms purchase used assets is because of financial constraints (see Eisfeldt and Rampini, 2007). The argument is that the cheaper price of the used asset motivates the financially constrained firm to purchase this asset. No doubt, this argument explains the behavior of some firms; however, most of the firms in the United States are not financially constrained and they account for the vast majority of the purchases of used assets. The literature puts forward an alternate explanation based on the expectations about the future changes in technology. Rosenberg (1976) argues that the decision to adopt a new technology is influenced by the expectation that this new technology will be a substantially improved substitute for the current technology. The firm might then not purchase the current cutting edge technology because this technology might become obsolete soon (see also Farzin, Huisman, and Kort, 1998). Thus, the result should be an increase in the purchase of older technology to fill the firm's immediate needs.

We build on this insight from the literature on technological expectations by hypothesizing that increases in the expectations about future significant technological changes increase the perceived obsolescence of new assets. This perception results in the decrease in the cost of purchasing used assets. This decrease results in firms spending more on used assets than new assets as they wait for the substantially improved new technology to emerge. We also hypothesize that as the economic life of the used asset decreases, the firms try to extract the maximum out of their purchases by decreasing the time taken to complete the transaction.

An incentive to the firm to adopt new technology is that it can charge a premium from its customers. Absent this incentive, the firm prefer to purchase cheaper used assets. We further hypothesize that industries with regulations that limit competition and have some control over the

prices they charge their customers might also prefer used assets. Examples of these regulated industries include industries that generate, transmit and distribute electricity, industries that transmit and distribute natural gas, etc.

We empirically test these hypotheses with data from SDC for the sample years 1980 to 2013. For the expected technological change, we use two measures. The first measure uses annual patent applications as an ex-ante proxy for the expected technological change because these applications can result in new technology. The drawback of this measure is that many patent applications are frivolous. So, the second measure uses the citations of the patents. The rational is that the important patents are likely to be cited more often.

In support of our hypothesis, we find that there is a positive relation between the purchase of used assets and the expected change in technology. We also find that the value of the purchased assets decreases with the increase in the expected change in technology. These results indicate that the expected change in technology decreases the price of the used asset that in turn results in more used assets being purchased. Furthermore, we estimate a negative relation between the time to completion and the expected technological change. This result indicates that the expected technological obsolescence leads the firm to quickly incorporate a used asset so that it can enjoy the asset's economic life longer. Lastly, we use industry deregulations to identify the technological change. In contrast to Eisfeldt and Rampini (2007) and Rampini (2015), in our empirical tests we find no support for financial constraint as an explanation for the firm's decision to purchase used assets.

The rest of this paper is as follows. We review the literature and develop the hypothesis in Section 2. Section 3 contains descriptions of the data and the construction of the variables. Section 4 presents the empirical results in support of our hypothesis. We conclude in Section 5.

II. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

The financial constraints of the firm (see Eisfeldt and Rampini, 2007) is the prevalent explanation in the literature for why firms purchase used assets. The other explanations in the literature are productivity changes (Warusawitharana, 2008; Maksimovic and Phillips, 2001) and leasing as a substitute to purchase of assets (Chemmanur et al. 2010). A less investigated explanation in the corporate finance literature comes from the theory on technological expectations. This paper investigates the last reason for purchase of used assets.

A. Expectations of technological change

In neoclassical economics, a technological shock (Mitchell and Mulherin, 1996) is one of the most important ingredients in explaining an outcome observed in nature (see Schumpeter, 1934). Andrade and Stafford (1999) find that industry characteristics such as technological changes and capacity utilization are strongly associated with acquisitions and capital expenditures. When firms face a new technology, neoclassical theory argues that firms should adopt the new technology. However, empirically the literature finds that not all technological shocks result in the adoption of new technology. Rosenberg (1976) explains this phenomenon by arguing that expectations about "the timing and significance of future improvements" play an important part in the firm's decision to adopt a new technology. The key part of Rosenberg's argument is that many firms prefer not to adopt the new technology if the technology is likely to significantly change in the future. In other words, the expectation that a new and more efficient technology might be introduced tomorrow might affect the decision to adopt a new technology today.

The adoption of a new technology is costly. Rosenberg (1976) explains this costliness as the uncertainty generated "by further improvement in the technology whose introduction is now being considered." Another source of costs is that the adoption of the new technology that can lead to disruption either through learning-by-doing or a gestation lag. To reduce these costs, the firm might

decide to wait for the significant improvement by purchasing an older technology. Used assets are more likely to have older technology, so the hypothesis follows.

H1a: The firm is more likely to purchase used assets if the firm expects significant future improvements in the technology.

Similarly, because the firm expects better technology in the future, it increases the fraction of expenditures spent on used assets.

H2a: The expenditure on used assets increases as the expectations about significant changes to future technology increases.

The reasoning behind this hypothesis is that the firm employs the used asset in the interim between the current technology and the next major innovation. Hence, the asset's economic life is likely to be short. Thus, the purchasing firm has an incentive to complete the deal as quickly as possible.

H3a: The time taken to complete the purchase of the used asset is shorter if the firm expects significant future improvements in technology.

In the above discussion, the firm has two options: it can postpone the investment decision or purchase the technology today. Thus, the true total demand equals the latent demand plus the observed purchases. Further, in terms of supply, the higher the expectations of technological change the larger the availability of the used asset because of exits from the industry. For instance, if technological change occurs in a series of incremental steps, then the exits at each step will ensure a continuous supply (however, if a firm enters to take advantage of the expected change, then most likely it already has a superior technology that it wants to exploit and thus might not need to buy the used asset). Hence, the most likely scenario is that the expectations of technological change increase supply more than demand, which results in a decrease in the competition for the used asset.

H4a: The number of bids for the used asset is lower if the purchaser expects significant future improvements in its technology.

According to Hicks (1935; page 8) monopolists tend to enjoy the "quiet life." In this view, monopolists like to avoid innovations. The reason being that monopolists can maintain their economic rents without undertaking the hard work that innovations involve. In regards to the hypotheses in this paper, the adoption of a newer technology takes more effort than the adoption of older technology. In addition, the adoption of a used asset decreases the existing profit margins less than the adoption of a new asset because new technology is costlier. Thus, monopoly firms are more likely to purchase used assets. In the United States the federal government provides certain industries with monopoly protection through regulations. The impact of the four hypotheses should be stronger for these regulated industries.

B. Financial constraint

The second strand of the literature explains the purchase decision through the financial constraint of the firm (e.g., see Rampini, 2015; Eisfeldt and Rampini, 2007). A new asset has a large upfront cost (i.e., purchase price), while an older asset has costs staggered over time (i.e., maintenance, downtime, etc.). Hence, firms that cannot pay the upfront cost prefer to buy used assets. Eisfeldt and Rampini (2007) hypothesize that financially constrained firms purchase used assets.

H1b: The firm is more likely to acquire vintage technology than new technology if its financial constraint increases.

Similarly, the amount spent by a financially constrained firm on the purchase of a used asset increases with financial constraint.

H2b: The expenditure for the used asset increases as the financial constraint of the purchaser increases.

If the firm is financially constrained it might need more time to line up finances.

H3b: The time taken to complete the purchase is longer if the purchaser is financially constrained.

The financial constraint of the acquirer has no implication about the competition for the asset.

H4b: The number of bids for the vintage technology is not affected by the financial condition of the acquirer.

The difference between both these theories is as follows. First, if the rate of change in technology is the main driver, then there should be more purchases of used assets by firms in industries with a faster rate of technological change. In contrast, the constraint theory argues that the purchases of used assets should be higher in financially constrained firms. Second, if the rate of change in technology is the main driver, then the firms will allocate larger amounts to purchase used assets than new assets because of technological obsolescence; if the cost is the main driver then financially constrained firms will also employ more used technology than new technology. Third, the time to completion of the purchase should decrease if the rate of expected technological change increases. In contrast, the financial constraint of the firm should lead to a shorter time to completion. The reason is that for the financially constrained firm, it should take a longer time to line up financing for the purchase. Lastly, in regulated industries the firms are more likely to purchase used technology because the costs of acquiring new technology is higher than the price benefits from purchasing the new technology. The financial constraint of the firm should not have any impact on the relation between the firms' decision to purchase the used technology and the product market competition for the asset. The above arguments are summarized in Table 1.

{Please insert Table 1 about here.}

C. Other explanations

In this subsection, we consider two other explanations for the purchase of used assets. The first explanation is from the productivity theory (see Warusawitharana, 2008; Yang, 2008). This theory argues that firms move to their optimal size by buying and selling assets. Less productive firms sell assets, and firms that are more productive buy assets. As argued by Maksimovic and Phillips (2002), firms adjust in size until the marginal benefit is equal to the marginal cost of production. Productivity is empirically measured by ROA, and the firm's efficiency is measured by Q. Thus, firms that are more efficient are less leveraged and purchase used assets, which contradicts the financial constraint theory. However, productivity generally fails to explain the heterogeneity in the time to completion, the number of bids, or the fraction of total expenditures spent on used technology.

The second explanation is that used assets are leased and not purchased directly from the seller. The traditional explanation is that some firms have a tax advantage in leasing and so optimally indulge in leasing (see Miller, and Upton, 1976). More recently, Chemmanur et. al. (2010) suggest that leases emerge as a solution to a two-sided information asymmetry problem. On the one hand, the manufacturer has private information about the quality of the product. On the other hand, the user of the good has private information about the payments that they can make each period. The model can explain the buy versus lease decision and the lease prices. However, it does not explain when a firm will purchase new or used assets. This paper answers a different question and so is a little distant from the leasing literature.

III. DATA AND VARIABLE CONSTRUCTION

This section describes the data sources that we use to test the hypothesis. The data on used assets is from SDC Platinum's domestic mergers and acquisitions database. This data set contains comprehensive information about the sale of operating units by different firms. The SDC Platinum

reports the data on the sale of a subsidiary and also reports the sale of assets by the firm. Both of these are considered used technology (see Warusawitharana, 2008). We clean the data by removing the sales of assets by firms that go bankrupt. The reason is that these are likely to be fire sales and so might not be reflective of the general population of firms. The sample period is for the years 1980 to 2013 and only includes firms based in United States. Table 2 reports the statistics. The firms take about 50 days to conclude a transaction and an average of one bid for each of these transactions takes place. Figure 1 presents the percentage of firms listed on Compustat that purchase used technology. The figure shows that the purchases of used technology follows a pattern. The maximum percentage of firms that purchase used technology is in the years 1999 and 2000. This percentage coincides with the stock market boom. Additionally, when the stock market increases between 2003 and 2008, the percentage of firms purchasing used assets also increases. This percentage indicates that the purchases of used technology follow stock market booms and busts and not the reverse as implied by the financial constraint explanation.

{Please insert Figure 1 about here.}

To measure the expectations about technological changes, an ex-ante measure is required that predicts possible future changes. Counting the annual number of patents granted to an industry is a good measure because it reflects the likelihood that future technological changes will follow in that industry. There is generally a lag of a few years between a patent and the emergence of a new technology. Thus, patents are a signal of future technological changes.

The source for the patent and citation data is NBER. As part of the patent data, NBER also identifies the firms that are publicly listed and gives their identifying information, such as their gvkeys. We take the number of patents that all firms in a particular industry are granted in a year. This measure captures the rate of technological change in that industry (see also Grimpe and Hussinger, 2007). The yearly sum of patents granted is divided by the average number of patents granted to all firms in that

industry for the preceding three years (i.e. t-1 to t-3). Table 2 reports that the average for the above number is 1.05.

We also count the annual number of citations received by the patents of all firms in a particular industry. A concern with any citation-based measure is that it has a truncation bias, that is older patents are likely to accumulate more citations over time than patents that the firm has recently applied for. This bias becomes significant when the patents are weighted by the total number of citations they receive. Our citation measure is not affected by this bias because we are not considering the total number of citations received by the patent, instead we are considering the total number of citations received by the patent stock for that industry in a particular year. Again, we divide the citations by the average received in the preceding three years. Table 2 reports that the patents are on average cited 0.91 times. Both of these measures might capture some industry effects. However substantial technological innovations affect the entire industry and so an industry level variable is more appropriate. For example, Apple introduced the smart phone; the impact was felt across the industry and this new technology changed the mobile phone industry substantially. Additionally, some firms in an industry might work independently on similar research projects that leads to homogeneity in the technical change in the industry. Again, an industry level variable captures this change.

{Please insert Table 2 about here.}

In corporate finance, the Kaplan and Zingales and Whited and Wu indices are well-accepted measures of financial constraint. Table 2 shows that the average value for the Kaplan and Zingales index is 0.0278. Similarly, the average value for the Whited and Wu index is -0.2101. According to Whited and Wu (2006) both values represent least constrained firms. The Herfindahl index of the average industry in the sample has a value of 0.17. The US department of Justice considers the Herfindahl index's values of 0.15 and 0.25 to be that of a moderately concentrated industry and indicates that the firms in these industries and are likely to draw closer scrutiny for anti-competitive behavior if they acquire another firm in the same industry. The size of the acquirer is the natural

logarithm of the total assets of the firm. The average value as reported in Table 2 is 4.6477, this size is larger than that of the average firm in Compustat. This result is similar to those reported in Warusawitharana (2008) who finds that large firms tend to acquire more used assets.

Tobin's Q measures the growth opportunities of the firm and is measured by the market value of the assets of the firm to its book value as provided in the balance sheet of the firm. Table 2 shows that the average firm has a Q value of about 1.65 and is comparable to the average firm in Compustat. Table 2 indicates that the cash flows of the average firm are positive, which suggests that the managers of profitable firms choose to grow their firms through trading in used assets. The leverage as measured by the ratio of total liabilities and total assets is about 0.42. Welch (2011) finds that the average firm has 61% of its total assets in total liabilities. Thus, the firms in our sample are less levered on average than other publicly traded firms.

A. Testing Strategy

To test the hypotheses, we estimate the following regression:

$$y_{i.t+1} = \alpha + \beta_1 Technological\ Change_{i,t} + \beta_2 Financial\ Constraint_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t} \ldots (1)$$

In equation (1), the dependent variable y is a dummy variable that takes the value of one if the firm purchases used assets. Technological Change is measured by patents and citations. Financial Constraint is measured by the Kaplan and Zingales and Whited and Wu indices. The literature finds that the other measures of financial constraint like z-scores and the investment cash-flow sensitivity measure financial constraint imprecisely and therefore, we do not use them in this paper (see Kaplan and Zingales, 1997; Hadlock and Pierce, 2010). The rest of the controls are firm specific. Warusawitharana's (2008) productivity explanation argues that firms with more ROA and of larger sized use more used assets. So, we include ROA and size as controls. We also include Q as a measure of efficiency as in Warusawitharana (2008). Jensen (1986) suggests that cash flow is a good

proxy for the principal-agent conflict in a firm. Leverage not only reflects the financial health of the firm but also can reduce the agency conflict in a firm. The reason is that debt and the fixed payments associated with it impose discipline on the managers. The sample consists of a set of control firms matched on size, cash flow, and year.

IV. RESULTS

A. The *determinants* of purchasing used assets

We hypothesize that firms purchase more used assets if the rate of technological change increases. Table 3 shows the results. Column (1) contains positive and statistically significant estimates for the *Patents*. Patent applications can represent the amount of innovation and technical change in an industry. The reasoning is that the firm is more likely to purchase a used asset if the industry's patent count increases. Column (2) contains positive and statistically significant estimates for the *Citations*. These estimates indicate that firms are more likely to purchase used assets if the citation count in the industry increases. *Citations* are a proxy for the importance of the inventions in the industry. Therefore, if the industry's inventions are more significant, then the firms in that industry purchase more used assets.

{Please insert Table 3 about here.}

Columns (3) and (4) show the estimates for financial constraint. Both the Kaplan and Zingales coefficients in Column (3) and Whited and Wu coefficients in Column (4) are not statistically different from zero. Thus, the financial constraint might not be the reason why the firm is purchasing used assets. The estimate for Leverage also supports this observation. The negative relation between the purchase of used assets and leverage shows that firms that have less book liability are more likely to purchase used assets. The results show that the purchase of used assets is not driven by the financial constraint of the purchaser as suggested by a vast strand of the literature.

In terms of other variables, the estimates for size in Columns (1) through (4) are positive. These estimates indicate that larger firms are more likely to purchase used assets. The Q is also positive and statistically significant in each of the four columns. The reason might be that the firms with higher growth opportunities choose to grow by acquiring used assets. The estimates for cash flow are also positive and statistically significant.

Panels A and B in Table 4 provide a robustness test to the above results. In Panel A we split the sample based on size in which smaller firms that are compared to the industry median size are in the odd numbered columns, and larger firms that again are compared to the industry median are in the even numbered columns. The first two columns report the results when the key independent variable is *Patents*, while the last two columns report the results when the key independent variable is *Citations*. The panel displays that the estimates for *Patents* in the second column and the estimates for *Citations* in the fourth column are statistically significant. This significance indicates that larger firms are more likely to purchase used assets than smaller firms. The reason might be that the larger firms are more willing to wait for the significant improvement in technology than smaller firms. Alternately, for larger firms, new technology is costlier because larger firms tend to be more complex and so changing one asset affects other parts of the firm. Interestingly, the estimated coefficients for the odd numbered columns are statistically insignificant. Smaller firms are likely to be more financially constrained, and therefore the lack of statistical significance indicates that the financial constraint of the firm is not likely to be a factor in the purchase of used assets.

{Please insert Table 4 about here.}

An underlying assumption in the hypothesis on expected technological change is that firms reallocate assets for optimal use. Pulvino (1998) finds that purchasers from a different industry than the seller purchase used assets and use these assets less efficiently. To test this finding, we separate the sample based on the SIC codes of the sellers and purchasers. The results are reported in Panel B of Table 4. The odd numbered columns report the estimates when the sellers and the purchasers are from

different industries, while the even numbered columns report the results when the purchasers and sellers are from the same industry. The estimates for *Patents* and *Citations* in the even numbered columns are statistically significant. The reason is that the firms reallocate the used assets to firms in the same industry when expectations of technological change are higher. The lack of statistical significance in the odd numbered columns indicates that the purchasers from different industries are not likely to purchase used assets when the expectations for technological change increase.

B. Expenditures on used technology

This subsection tests the second hypothesis by investigating the expenditures for used technology. The empirical model is the same as that in equation 1. The only difference is that the dependent variable is now the fraction that the firm spends on purchasing used assets in relation to its total capital expenditures. Table 5 shows the results. The first column reports that the estimate for *Patents* is positive and statistically significant. Thus, we can say that if the number of patents filed by the industry increases then the firms in those industries spend a larger fraction of their total capital on used assets. The second column reports the estimate for citations per patents for all of the firms in that industry. This relation is positive and statistically significant. It means that the fraction of capital spent to purchase used assets increases if the average patent in that industry has an increase in citations. Because the number of citations can represent the importance of the inventions, if the industry has more important expected technical innovations, then these lead to an increase in the fraction of capital spent to purchase used assets.

{Please insert Table 5 about here.}

Columns (3) and (4) show that the estimations of Kaplan and Zingales and Whited and Wu are not statistically significant. These results show that the financial constraint of the purchaser does not affect the fraction spent on purchasing used assets. In terms of other variables, the Q is positive and

statistically significant. We can conclude that high growth purchasers spend more on purchasing used assets.

Table 5 provides a robustness test for the results in Table 3. The criticism for the dependent variable used in Table 3 is that it does not capture the significance of the purchase to the firm involved. One way of capturing this significance is to divide the dollar amount spent on purchasing used assets by the dollar value that the firm spends on maintaining and acquiring assets. If the purchase of used assets is the fraction of the capital expenditures of the firm, then this fraction reflects the importance of the purchases of used assets in relation to the firms existing assets. Therefore, in Table 5 we change the dependent variable to reflect this difference.

C. Time to completion

The third hypothesis states that the time taken to complete the purchase is likely to be shorter if the expected rate of technological change increases. To test this hypothesis, we use a regression model in which the dependent variable is now the time taken to complete the purchase. We report these results in Table 6. Column (1) reports a negative and statistically significant relation at the one percent confidence level between time to completion of the purchase and patents. This relation indicates that the time taken to complete the purchase, starting from the announcement day, decreases as the rate of expected technological change increases. Column (2) reports a negative and statistically significant relation between the time to completion and citations. This relation shows that the time to completion of the purchase decreases as the importance of the patents in the purchaser's industry increases.

{Please insert Table 6 about here.}

Columns (3) and (4) show the relation between time to completion of the purchase and the financial constraint of the purchasing firm. Both of these estimates are not statistically significant. Thus, the financial constraint of the firm is not likely to have a significant impact on the time taken for it to complete the purchase. In terms of other variables, larger firms are more likely to complete the

purchase faster. The negative relation between the time to completion and cash flow indicates that firms with low cash flow are likely to take more time to complete the transaction.

D. Number of bidders for used assets

Next, we test hypothesis four by using the number of bids for each purchase. Panel A of Table 7 reports the results. In Column (1), the coefficient for *Patents* is negative and statistically significant. This result shows that the number of bids for the purchase of used assets declines if the firm is in an industry that has more expected technological change. The estimated coefficient for *Citations* in Column (2) is negative and statistically significant at the one percent confidence level. This coefficient indicates that as the significance of the expected technical change increases the competition for the used assets declines. This finding provides additional support for the fourth hypothesis and shows the robustness of the empirical result from a different dependent variable.

{Please insert Table 7 about here.}

Columns (3) and (4) in Table 7 provide estimates of the coefficient for financial constraint. The estimates of the Kaplan and Zingales index and the Whited and Wu index are both statistically insignificant. The results show that the financial constraints of the purchaser do not play a role in its decision to bid on competitive used assets. In terms of other variables, the positive relation between the number of bids and size indicates that large firms are more likely to bid on competitive used assets. The negative relation between the number of bids and cash flow means that firms with relatively lower cash flows are more likely to bid on used assets.

The assumption underlying the fourth hypothesis is that the supply of used assets increases and that increase reduces the competition for the used assets; hence, the lower number of bids. One way to test this assumption is to use the dollar amount of the used assets sold. Compustat provides this amount. Thus we make the dependent variable the logarithm of the dollar value of property plant and equipment sold divided by the lagged total assets of the firm. The results are presented in Panel B of

Table 7. The estimates for *Patents* in Column (1) and the estimates for *Citations* in Column (2) are positive and statistically significant. These findings indicate that as the expectations of technological change increase firms divest more and more assets.

E. Regulated markets and the purchase of used assets

This subsection tests the hypothesis that firms in regulated industries are also more likely to be purchasers of used assets. Our investigation first identifies the leading regulated industries. These industries provide a good test as to whether their firms are less competitive because of the regulations. Further, some of these firms might have a monopoly in certain geographic regions because of local regulations.

{Please insert Table 8 about here.}

Column (1) of Panel A in Table 8 shows the number of times used assets are purchased; Column (3) shows the number of times used assets are sold by firms in that industry. The last row provides the total for all of the industries listed in the table. Column (1) shows that the total number of purchases for these regulated industries is more than the number of sales for used assets (Column (3)). Column (2) reports the dollar value of purchases for these industries while Column (4) reports the dollar value of the sale of these assets for these industries. The totals reported in the last row show that the dollar value of the purchases of used assets is more than that of the sale of used assets. Thus, the regulated industries are net buyers of used assets.

F. Identification

Identification can remove any concerns about endogeneity and can establish causation. This process is important because the hypotheses suggest that these affects will be stronger in regulated industries because the firms in these industries might have monopoly power. Therefore, we test the hypothesis by examining the variables before and after deregulation. Panel B of Table 8 lists the

industries and the years of deregulation. Deregulation is exogenous to the firm because it is passed by Congress. Broadly, transportation, energy, and telecommunication are regulated industries that experience deregulation shocks. These deregulations are staggered over time; this time effect is important because it reduces the impact of any correlated event occurring simultaneously with the deregulation.

For a difference-in-difference regression, our control group is matched by cash flow, size and year dimensions. The results are presented in Panel C of Table 8. The variable of interest is the interaction term of *Deregulation* (deregulation is a dummy variable that takes the value of one for two years prior to deregulation and zero for two years after the deregulation) and *Regulated Industry*. In the first column, the interaction term is positive and statistically significant that indicates that before deregulation, the firms in the regulated industry purchased more used assets. In Column (2), the estimate of the interaction term is positive. The implication is that the fraction of expenditure on used assets is higher before deregulation. In Column (3), the estimate of the interaction term is negative and statistically significant. This term indicates that before deregulation the number of bids received for the used assets is lower. In the last column, the estimate of the interaction term is negative. This term means that before deregulation the time taken to complete the deal was also shorter. These results are consistent with the hypothesis and so establish that the results are not biased by endogeneity.

G. Difference-in-difference estimation for financial constraint

A potential reason for why we find no statistical significance for the financial constraint variables is because of identification issues. We use the great recession of 2008 to establish identification. The great recession of 2008 is a macroeconomic financial shock caused by the banking industry and so is exogenous to the other firms in the economy. The firms after the recession are generally more financially constrained than before the shock because the banks tightened the lending

standards. Thus, the effect from financial constraint should be stronger after the recession than before it.

{Please insert Table 9 about here.}

The difference-in-difference method can exploit the great recession and remove concerns about endogeneity. The results are reported in Table 9. The difference-in-difference estimators are the interaction terms between the *Constraint Dummy* and *Whited Dummy* in odd numbered columns and between the *Constraint Dummy* and *KZ Dummy* in even numbered columns. If the financial constraint is the cause, then these interaction terms should be statistically significant. In Columns (1) through (6) none of the interaction terms is statistically significant. The interpretation of the estimate is that financial constraint is not the likely cause behind the purchase of used assets.

V. CONCLUSION

This research investigates the decisions by firms to purchase used assets. We argue that the expectations about future technological changes delay the purchase of new assets and result in the purchase of used assets. As the expectations about the change in technology increases the obsolescence of assets of different vintages, the price of used assets declines as the expected rate of change in technology increases. The time to completion of the purchase decreases as the expected rate of change in technology increases because the lifespan of used assets declines with the expected rate of technological change. Finally, we hypothesize that firms in regulated industries are more likely to purchase used assets because the cost of adopting new assets outweighs their benefits.

We empirically test these hypotheses by using patent and citation data to measure the expected rate of technological change. The empirical evidence supports the hypotheses and is robust to different specifications. An alternate explanation is that the financial constraint of the firm explains the decision to purchase used assets. We include measures of financial constraint in our empirical specification, and

in each of these estimates we find no statistical support. We infer that the decision by the firms to purchase used assets is explained by the expected rate of change in technology.

This research contributes to the literature by investigating why firms purchase used assets. This is important as firms purchase assets regularly and spend vast amounts of resources to do so. Future research can investigate the relation between the long-term performance of the firm and the purchase of used assets.

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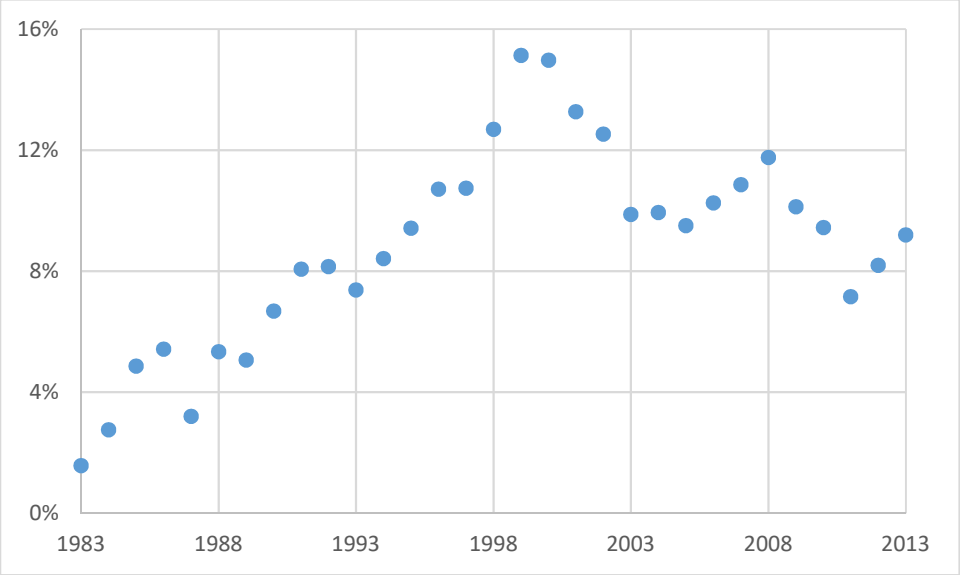
Figure 1) Time Series of the Percentage of Firms Purchasing Used Assets



The x-axis reports the years; the y-axis reports the percentage of publicly listed firms that purchase used assets.

Table 1 Hypothesized Relations

Relations	Purchase (1)	Expenditure (2)	Time (3)	Bids (4)
Expected Technological Change	+	+	-	-
Regulated Industry	+	+	-	-
Financial Constraint	+	+	+	+/-

The above table summarizes the hypotheses of the expected technological change theory and financial constraint theory. Purchase refers to the firms' decision to purchase used assets. Expenditure is the fraction that the firm spends on used assets. Time refers to the time taken for the purchaser to complete the acquisition. Bids refer to the number of bids received by the seller of the used assets. The first row presents the hypothesis on Expected Technological Change. The second row presents hypothesis in relation to regulated industries and is a subset of Expected Technological Change. The third row presents the hypothesized relation between Financial Constraint and the purchase of used assets.

Table 2 Summary Statistics

	Mean	Standard Deviation	Observations
	(1)	(2)	
Deal Value	13.3144	340.3708	13,439
Number of Bids	1.0094	0.1442	13,439
Time to Completion	50.2313	80.6133	13,439
Patents	1.0532	0.3242	26,878
Citations	0.9084	0.4257	26,878
Kaplan Zingales	0.0278	2.0474	26,878
Whited Wu	-0. 2101	0.0388	26,878
Herfindahl Index	0.1729	0.1808	26,878
Size	4.6477	2.725	26,878
Q	1.6501	0.387	26,878
Cash Flow	0.0112	0.0334	26,878
ROA	0.0301	0.6503	26,878
Leverage	0.4203	0.2821	26,878

In row 4 onwards the number of observations is 26,878 that reflects that the sample consists of firm-years with used assets (13,439 observations) and a matched sample of firms. The firms are matched on size, cash flow, and year. The Deal Value is the transaction value divided by the total sale. The Number of Bids is the total number of bids per sale of used assets. The Time to Completion is the total time taken in days from the announcement of the purchase to its completion. Patents are the total number of patents granted by that three-digit industry in that year divided by the average number of patents granted to that industry for the three prior years (i.e. year -1 to year -3). The Citations are the total number of citations received by the patents applied for in that year for that industry. Again, they are divided by the average number of citations for that industry over the last three years. This measure captures the importance of the innovations in that year. Kaplan and Zingales (1997) is a measure of financial constraint and is scaled by 100. Whited and Wu (2006) is a measure of financial constraint. The Herfindahl Index is the sum of the squares of the market shares of each firm in an industry. The market share is the firm's sales divided by industry sales. Size is the log of total assets of the purchaser. Q is the ratio of the market value of the firm's assets (market capitalization plus total liability) divided by the total assets of the firm. The Cash Flow is EBITDA/total assets. The ROA is net income/total assets. The Leverage is the total liabilities divided by total assets.

Table 3) Determinants of Purchasing Used Assets

Used Asset Purchase Dummy	(1)	(2)	(3)	(4)
Patents	0.0127			
	0.0026**			
Citations		0.0131		
		0.0017**		
Kaplan Zingales			0.0001	
			0.0009	
Whited Wu				0.0107
				0.0191
Size	0.01	0.0099	0.0117	0.0102
	0.0004**	0.0004**	0.0005**	0.0005**
Q	0.0025	0.0025	0.003	0.0024
	0.0002**	0.0002**	0.0002**	0.0002**
Cash Flow	0.0394	0.0394	0.0405	0.0349
	0.0031**	0.0031**	0.0031**	0.0032**
ROA	0.0553	0.0553	0.0587	0.0495
	0.0039**	0.0040**	0.0039**	0.0040**
Leverage	-0.0008	-0.0008	-0.0012	-0.0003
	0.0004	0.0004*	0.0004**	0.0004
Constant	0.0089	0.0116	-0.0967	-0.058
	0.0101	0.0102	0.0115**	0.0113**
Pseudo R2	0.14	0.15	0.14	0.14

The table uses 26,878 observations. The Used Asset Purchase Dummy is a dummy variable that takes the value of one if the firm purchased vintage used asset. The table uses Probit regressions. The robust standard errors are clustered by firm and are reported in the line below the estimate. The year and firm dummies are used but not reported. The * and ** represent statistical significance at 5% and 1% respectively.

Table 4 Sorting on Characteristics for the Purchase of Used Assets

Panel A Sorting on Firms Abnormal Size

Firm Assets-Median Industry Assets	<0	>=0	<0	>=0
Used Asset Purchase Dummy	(1)	(2)	(3)	(4)
Patents	0.0024	0.004		
	0.0027	0.0013**		
Citations			0.0026	0.0045
			0.002	0.0018*
Size	0.0103	0.0071	0.0103	0.007
	0.0005**	0.0010**	0.0005**	0.0010**
Q	0.0014	0.0106	0.0014	0.0106
	0.0001**	0.0013**	0.0001**	0.0013**
Cash Flow	0.0208	1.1308	0.0208	1.0892
	0.0026**	0.5011*	0.0026**	0.5102*
ROA	0.0273	1.2073	0.0273	1.1664
	0.0033**	0.5040*	0.0033**	0.5130*
Leverage	0.0003	-0.0205	0.0003	-0.0203
	0.0003	0.0049**	0.0003	0.0050**
Constant	0.017	0.0738	0.0175	0.0743
	0.0080*	0.0192**	0.0079*	0.0187**
Pseudo R2	0.14	0.17	0.15	0.17
Observations	12,758	14,120	12,758	14,120

The variables are as defined in Table 2. The robust standard errors are clustered by firm and are reported in the line below the estimate. The year and firm dummies are used but not reported. The * and ** represent statistical significance at 5% and 1% respectively.

Panel B Sorting on Non-Industry Purchasers

Different Industry Purchaser	Yes	No	Yes	No
Used Asset Purchase Dummy	(1)	(2)	(3)	(4)
Patents	0.0026	0.013		
	0.0026	0.0027**		
Citations			0.0031	0.0132
			0.0029	0.0018**
Size	0.0078	0.0104	0.0005	0.0103
	0.0005**	0.0005**	0.0007	0.0005**
Q	0.0014	0.004	0	0.004
	0.0002**	0.0003**	0.0001	0.0003**
Cash Flow	0.0149	0.093	0.0011	0.0926
	0.0026**	0.0103**	0.0023	0.0103**
ROA	0.0199	0.1212	0.0009	0.1208
	0.0033**	0.0115**	0.003	0.0115**
Leverage	-0.0009	-0.0058	-0.0005	-0.0058
	0.0003**	0.0011**	0.0003	0.0011**
Constant	0.0241	0.0607	0.0084	0.011
	0.0112*	0.0102**	0.015	0.0106
Pseudo R2	0.15	0.13	0.15	0.13
Observations	6,295	20,583	6,295	20,583

Different Industry Purchaser is "Yes" if the purchaser and seller have different four-digit SIC codes; if the purchaser and the seller have the same four-digit SIC code then the first row has "No." Variables are as defined in Table 2. The robust standard errors are clustered by firm and are reported in the line below the estimate. The year and firm dummies are used but not reported. The * and ** represent statistical significance at 5% and 1% respectively.

Table 5 Expenditure on Used Assets

% Used Asset Purchase	(1)	(2)	(3)	(4)
Patents	0.0121			
	0.0016**			
Citations		0.0119		
		0.0011**		
Kaplan Zingales			0.0001	
			0.0001	
Whited Wu				0.0107
				0.0132
Size	-0.0006	-0.0025	-0.0031	-0.0026
	0.0004	0.0002**	0.0002**	0.0002**
Q	0.0015	0.0015	0.0017	0.0014
	0.0001**	0.0001**	0.0001**	0.0001**
Cash Flow	0.0167	0.0285	0.0305	0.0244
	0.0036**	0.0025**	0.0024**	0.0025**
ROA	0.0246	0.0416	0.0454	0.0365
	0.0041**	0.0031**	0.0030**	0.0031**
Leverage	-0.0025	-0.0016	-0.0018	-0.0012
	0.0004**	0.0003**	0.0003**	0.0003**
Constant	-0.049	-0.02	-0.0341	-0.0132
	0.0030**	0.0062**	0.0069**	0.0061*
Pseudo R2	0.27	0.03	0.03	0.03

The table uses 26,878 observations. The % Used Asset Purchase is a ratio where the amount the firm paid for purchasing vintage used asset is divided by the sum of capital expenditure. The robust standard errors are clustered by firm and are reported in the line below the estimate. The year and firm dummies are used but not reported. The * and ** represent statistical significance at 5% and 1% respectively.

Table 6 Time Taken to Complete the Purchase

Time to Completion	(1)	(2)	(3)	(4)
Patents	-4.4359			
	1.4040**			
Citations		-2.4083		
		1.4035*		
Kaplan Zingales			-7.5663	
			17.0411	
Whited Wu				24.1842
				14.2994
Size	3.6608	3.7405	3.2054	3.4081
	0.3709**	0.3705**	0.3762**	0.4156**
Q	-0.2617	-0.2641	-0.3628	-0.1066
	0.2004	0.2005	0.207	0.2057
Cash Flow	-26.6845	-27.1148	-29.1082	-25.9477
	14.5143	14.5512	13.4591*	18.5987
ROA	-35.4712	-36.1508	-39.9851	-33.4896
	15.5682*	15.6015*	15.1157**	19.4546
Leverage	3.6719	3.6686	6.2024	3.3082
	1.8503*	1.8507*	2.3286**	1.7952
Constant	12.3921	13.5988	95.4562	3.0692
	3.4340**	3.3720**	57.2629	15.6282
Adj. R2	0.14	0.14	0.14	0.14

The table uses 13,439 observations. Time to Completion is the number of days taken between the announcement of the deal and the date on which the deal is effective. The dependent variables are as defined in Table 2. The robust standard errors are clustered by firm and are reported in the line below the estimate. The year and Fama French industry dummies are used but not reported. The * and ** represent statistical significance at 5% and 1% respectively.

Table 7 Supply of Used Assets
Panel A Number of Bids for Used Assets

Number of Bids	(1)	(2)	(3)	(4)
Patents	-0.0153			
	0.0053**			
Citations		-0.0054		
		0.0017**		
Kaplan Zingales			0.0113	
			0.0078	
Whited Wu				0.0786
				0.0688
Size	0.007	0.007	0.0044	0.0071
	0.0012**	0.0012**	0.0009**	0.0013**
Q	0.0004	0.0004	0.0003	0.0004
	0.0002*	0.0002*	0.0002*	0.0002*
Cash Flow	-0.0312	-0.031	-0.0138	-0.0148
	0.0123*	0.0123*	0.0095	0.0137
ROA	-0.0461	-0.046	-0.024	-0.0267
	0.0153**	0.0153**	0.0119*	0.0178
Leverage	-0.0007	-0.0007	-0.001	-0.0009
	0.0019	0.0019	0.0013	0.0024
Constant	0.9547	0.9545	0.9672	0.9648
	0.0077**	0.0078**	0.0067**	0.0089**
Adj. R2	0.06	0.06	0.03	0.08

The panel uses 13,439 observations. The Number of Bids is the total number of bids for the purchase. The dependent variables are as defined in Table 2. The robust standard errors are clustered by firm and are reported in the line below the estimate. The year and Fama French industry dummies are used but not reported. The * and ** represent statistical significance at 5% and 1% respectively.

Panel B) Sale of Used Assets

Ln(Sale of PPE/AT)	(1)	(2)	(3)	(4)
Patents	0.0003			
	0.0001**			
Citations		0.0004		
		0.0002**		
Kaplan Zingales			-0.0001	
			0.0001	
Whited Wu				-0.0035
				0.0017*
Size	-0.0006	-0.0007	-0.0007	-0.0006
	0.0002**	0.0002**	0.0000**	0.0001**
Q	-0.0005	-0.0006	-0.0005	-0.0004
	0.0001**	0.0002**	0.0000**	0.0000**
Cash Flow	0.0083	0.0082	0.0078	0.0079
	0.0020**	0.0020**	0.0019**	0.0020**
ROA	-0.0115	-0.0114	-0.0113	-0.0111
	0.0022**	0.0022**	0.0021**	0.0022**
Leverage	0.0014	0.0013	0.001	0.0009
	0.0002**	0.0002**	0.0002**	0.0002**
Constant	0.0069	0.0058	0.0147	0.0169
	0.0009**	0.0008**	0.0007**	0.0008**
Adj. R2	0.05	0.05	0.04	0.04

This panel uses13,439 observations. Ln(Sale of PPE/AT) is the natural logarithm of the dollar value of the sale of property plant and equipment (Compustat data item code: SPPE) divided by the lagged dollar value of the total asset (AT) of the firm. The dependent variables are as defined in Table 2. The robust standard errors are clustered by firm and are reported in the line below the estimate. The year and Fama French industry dummies are used but not reported. The * and ** represent statistical significance at 5% and 1% respectively.

Table 8 Industry Characteristics of Purchasers of Used Assets

Panel A Regulated Industries

SIC		Buy		Sell	
Code	Description	Number	$ Million	Number	$ Million
		(1)	(2)	(3)	(4)
491	Electric	336	108,387	306	114,520
492	Natural Gas	345	77,336	289	73,638
495	Sanitary	297	14,939	259	13,730
493	Electric & Natural Gas Other	104	35,494	36	10,619
494	Water Supply	98	8,285	95	6,204
	Total	1,180	244,441	985	218,711

Buy means the buying of used assets by the three-digit SIC industry. Sell means the selling of used assets by the three-digit SIC industry. Number refers to the number of times the SIC code firm has bought/sold used assets. The $ Value is the total value of all used assets bought/sold by the three-digit SIC firm.

Panel B List of Major Deregulations during Sample Years

	Year	Industry
1	1982	Bus Regulatory Reform Act
2	1984	Ocean Shipping Act
3	1986	Surface Freight Forwarder Deregulation Act
4	1989	National Gas Wellhead Decontrol Act
5	1992	Energy Policy Act
6	1994	Federal Aviation Authorization Act (especially surface transport part)
7	1996	Telecommunications Act
8	1998	Ocean Shipping Reform Act

The list of industries is from www.wikipedia.org.

Panel C Difference-in-Difference Estimates Using Deregulations

	Used Asset Purchase Dummy	% Used Asset Purchase	Number of Bids	Time to Completion
	(1)	(2)	(3)	(4)
Deregulation	0.1795	-2.956	0.3875	170.1557
	0.3796	3.1375	0.255	44.3892**
Regulated Industry	0.2923	-0.8552	0.8552	0.8319
	0.1183*	0.3681*	0.3681*	0.3803*
Regulated Industry*	0.305	1.2013	-0.2203	-119.9512
Deregulation	0.1127**	0.4737*	0.7452**	23.5684**
Kaplan Zingales	0.7436	-6.7443	-0.108	-105.2888
	0.5209	6.3675	0.1424	239.4946
Whited Wu	-0.2184	-20.3062	1.0335	-572.3445
	0.2346	20.7757	1.0056	672.5207
Size	0.0713	0.2928	0.014	-16.5081
	0.0091**	0.1039**	0.0045**	7.9415*
Q	0.027	0.1692	-0.0007	-9.7574
	0.0063**	0.0666*	0.0027	7.8684
Cash Flow	1.2002	-4.3073	-0.227	161.8443
	1.654	35.3028	0.8029	97.6472
ROA	1.9772	-5.1538	-0.2984	0.4854
	1.6728	35.3517	0.8147	0.4841
Leverage	-0.0623	-0.082	-0.0092	132.0531
	0.0668	0.4865	0.0134	69.8632
Constant	-2.3786	0.6341	0.5463	-16.1073
	0.4735**	1.479	0.2689*	61.1978
Adj. R2	0.11	0.16	0.08	0.17

Deregulation is a dummy that takes the value one for two years prior to deregulation, and zero for two years after deregulation. Regulated industries are those industries that experience the deregulations shock and are listed in Panel A. The control group is matched on size, cash flow, and year. The first column reports Probit estimates, the rest of the columns report OLS estimates. The year and industry dummies are used but not reported. The * and ** represent statistical significance at 5% and 1% respectively.

Table 9 Difference-in-Difference Estimation to Test Financial Constraint as an Explanation of Purchase of Used Assets

	Used Asset Purchase Dummy		% Used Asset Purchase		Time to Completion	
	(1)	(2)	(3)	(4)	(5)	(6)
Constraint Dummy	-0.9432	-0.901	-5.4306	-39.8959	-2.6921	0.9559
	0.0606**	0.0651**	36.2655	33.2308	5.5154	5.9273
Whited Dummy	0.017		-12.8114		-0.655	
	0.0438		9.8508		3.9579	
Constraint Dummy *Whited Dummy	0.067		-29.1563		1.5145	
	0.0894		33.6522		8.7663	
KZ Dummy		0.184		-46.3867		0.3035
		0.0331**		13.9098**		2.4453
Constraint Dummy *KZ Dummy		-0.0858		59.9022		-7.7262
		0.0586		43.3707		5.1752
Size	0.1052	0.1036	6.5165	7.5684	3.5122	3.489
	0.0068**	0.0069**	3.3491	3.4646*	0.6982**	0.6988**
Q	0.0193	0.0141	1.5538	3.097	-0.3597	-0.3656
	0.0039**	0.0042**	2.3347	2.4368	0.3852	0.3887
Cash Flow	1.2035	1.4018	277.7705	876.613	56.5603	57.1332
	0.3101**	0.3359**	236.5313	248.4801	21.4480**	21.4804**
ROA	1.6224	1.8576	298.0206	903.5379	76.9549	77.5273
	0.3791**	0.4121**	236.9351	750.3074	28.0785**	28.1080**
Leverage	-0.0758	-0.0984	-1.1616	-13.4295	-2.1059	-2.3778
	0.0464	0.0572	13.9755	14.8624	2.6493	2.6497
Constant	2.2105	2.2722	17.8081	23.047	4.6692	4.4628
	0.2049**	0.2037**	31.8526	32.0473	5.229	5.3515
Pseudo R2	0.12	0.13	0.17	0.19	0.12	0.12
Obs.	53,756	53,756	53,756	53,756	53,756	53,756

Probit regressions are used in Columns (1) and (2), and an OLS method is used in Columns (3) through (6). The Constraint dummy takes the value of one for years 2009 and after. The Whited Dummy takes the value of one if the firm has a financial constraint greater than the median. Similarly, the KZ dummy takes the value of one if the firm has a Kaplan and Zingales value greater than that of the median. The year and industry dummies are used but not reported. The * and ** represent statistical significance at 5% and 1% respectively.