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# Does Asset Durability Impede Financing? An Empirical Assessment

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# Does Asset Durability Impede Financing?
# An Empirical Assessment

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## Abstract

Does asset durability limit firms' ability to obtain external financing when they are financially constrained? According to theory, an increase in durability increases the down-payment required to purchase a tangible asset, and hence the overall financing needs by a firm (Rampini (2019)). Using the depreciation rate to measure asset durability, I find financing frictions can affect firm investment through the asset durability channel. Specifically, asset durability increases external financing costs for financially constrained firms, but the effect is ambiguous for unconstrained firms. Additionally, I find when firms endogenously choose asset durability, more (less) financially constrained firms invest in less (more) durable capital. These results provide mixed support to the idea that the durability of an asset impedes financing.

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# 1 Introduction

Does the choice of the durability of an asset (serving as collateral) affect firms' ability to obtain external financing? Drawing on the recently proposed theoretical framework of Rampini (2019) that highlights the role of asset durability on firm financing, I conduct an empirical analysis to answer this question. Durability is a central feature of tangible physical assets.[1] More durability allows a firm to use a durable asset for multiple periods. However, physical capital also depreciates over time. The depreciation rate of physical assets varies from as low as 1% for residential structures to as high as 40% for some computing equipment.[2] Due to the depreciation of capital, firms often replace less durable assets with more durable ones. An interesting question to explore in this context is how firms decide on their choice of more durable and less durable assets? Moreover, as firms generally purchase these durable assets through collateral financing, do financial constraints drive this decision?

Rampini (2019) using a theoretical framework finds that optimal asset durability chosen by firms is determined by the financial constraints they face. In my paper, I conduct an empirical study to examine how choice of asset durability is affected by the financial constraints faced by firms. I find mixed evidence in the data that asset durability adversely affects firm financing which is the key finding in Rampini (2019). To the best of my knowledge, this is the first attempt to test the theory developed in Rampini (2019) with data. My paper contributes to the literature by using depreciation rate as a measure of durability and exploring a connection between asset durability and firm financing in the presence of financial constraints.

Previously, Hart and Moore (1994) argued that durable assets serve as collateral and facilitate financing due to their higher liquidation value. By contrast, Rampini (2019) puts forth the idea that the depreciation rate measures the durability of an asset and that liquidation value is a measure of pledgeability.[3] Distinguishing between durability and pledgeability, Rampini (2019) argues that the durability of an asset affects both the collateral value and

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[1] Durability measures an asset's shelf life. Durable assets are typically referred to as those tangible assets that have a relatively long shelf life and can be put to productive use for multiple periods. They include residential and non-residential structures and production equipment.

[2] BEA's fixed assets accounts. Weblink `https://www.bea.gov/iTable/index$_$FA.cfm.`

[3] Pledgeability of asset measures the collateral value an asset. Assets that serve as better collateral are more pledgeable.

the price of an asset. When durability increases (depreciation falls), it becomes harder for a firm to finance due to a higher down payment of the underlying asset. Owing to this high upfront cost of durable assets, financially constrained firms optimally choose to purchase used and less durable (with high depreciation) assets. In contrast, the unconstrained firms buy only new and durable assets (with low depreciation). Rampini (2019) concludes that the net effect of durability is to impede financing.

In my paper, I test the predictions of Rampini (2019) by examining the interaction between financial constraints and firm investment through asset durability channel. The empirical exercise includes two separate specifications that vary in the choice of proxies of financial constraints. In the baseline specification, I use investment-cash flow sensitivity as a proxy of financial constraints to test the hypothesis that if durability increases the cost of external financing, then firms' investment-cash flow sensitivity should be increasing in the durability of new investments. In an alternative specification, I use financial constraints indices to test the hypothesis that increase in financial constraints reduces average durability of assets purchased by firms.

In the baseline specification, I discuss how durability of new investment affects the cost of external financing. For this specification, I divide the sample into sub-samples of constrained and unconstrained firms following standard ex-ante sample selection criteria suggested in the literature. Financially constrained firms display excess investment-cash flow sensitivity due to a higher cost of external financing, and this sensitivity increases in the degree of the financial constraints (Fazzari et al. 1988). Thus, by comparing the relationship between durability and investment-cash flow sensitivity across a constrained and unconstrained group of firms, I am able to infer the impact of durability on external financing. Towards this end, I modify the classic investment model by Fazzari et al. (1988) to include a measure of durability as an interaction term. The interaction term captures the effect of asset durability on investment-cash flow sensitivity. A positive coefficient of the interaction term satisfies my hypothesis for this baseline specification.

The alternative specification applies a more direct approach towards examining how financial constraints affect the choice of durability at the firm level. I use popular financial constraints indices (Kaplan and Zingales (KZ) index, Whited and Wu (WW) index, and Hadlock and Pierce (HP) index) as proxies for financial constraints. The higher the value of the financial constraints index of a firm, the costlier it is for the firm to gain external finance. The key predictions made in Rampini (2019) then leads to my hypothesis for this specification that average durability should be negatively related to financial constraints indices.

I test both hypotheses described above by using a sample of publicly-traded U.S manufacturing firms drawn from COMPUSTAT between 1983 to 2017. I construct a proxy of durability from the depreciation rate of an asset. To calculate the implied depreciation rates of physical assets, I follow the methodology proposed in Chen (2014). I estimate the baseline regressions using a standard OLS approach with firm- and year- fixed effects.

The results for the baseline specification show that asset durability positively affects investment-cash flow sensitivity in constrained firms. For some unconstrained firms, however, durability has no significant effect on the investment-cash flow sensitivity. Excess investment-cash flow sensitivity implies that increased durability of assets increases the cost of external financing for constrained firms and makes them more reliant on internally generated cash flow. The results for the alternative specification show that average durability decreases when a firm becomes more financially constrained as measured with the KZ index. With the other two indices namely, the WW and the HP index of financial constraints, the OLS estimates do not remain robust after controlling for endogeneity. Despite contrasting results, the findings using the KZ index are reliable in this analysis. The construction of the KZ index includes cash holdings by a firm with a negative loading while the other two indices (the WW index and the HP index) do not. As durability increases the down payment of an asset, thus, in the presence of collateral constraints, firms must be able to afford the higher down payment given its financial health, which is appropriately captured by the KZ index.

The findings from the OLS estimation of the baseline regression are sensitive to outliers present in the data. When I use winsorized data to treat for outliers, the difference in the effect of durability on investment-cash flow sensitivity disappears across constrained and unconstrained firms. In contrast, the conclusions of the alternative specification are relatively robust to outlier treatment for all three financial constraint indices. The findings thereby generate mixed support towards the theoretical link between durability and firm financing established in Rampini (2019).

The article is organized as follows: Section 2 gives an overview of the literature on asset durability and investment under financial frictions. Section 3 provides a brief theoretical background. Section 4 outlines the empirical methodology applied to test the theoretical propositions of Rampini (2019) and summarizes the regression results, and Section 5 concludes.

## 2 Review of literature

The bulk of literature concerning optimal durability identifies market power as the reason why firms produce less durable goods (Bulow (1982), Bulow (1986)). Firms' incentive to retain market power is also responsible behind their decision on renting or leasing of durable goods (Coase (1972), Bulow (1982) and Stokey (1981)). Rampini (2019) adopts a new theoretical approach by distinguishing between the durability and pledgeability of an asset to address the effect of durability on firm financing in a competitive environment under financing frictions. By defining durability with the depreciation rate of an asset, Rampini (2019) shows that durable assets require a higher down payment, which makes it difficult for financially constrained firms to obtain financing. Higher down payment of durable assets also drives financially constrained firms to rent durable capital and adopt dominant technology.

Previous studies have used depreciation rates predominantly for analyzing the growth of capital stock, measurement of productivity, and investment behavior (Baldwin et al. (2005) Levy (1995) and Coen (1975)). These studies have used different measures of depreciation rate for their analyses.[4] Schündeln (2012) uses survey data on manufacturing firms in Indonesia to estimate the depreciation rate of physical assets and finds that constrained firms use investment goods with high depreciation. But these studies do not explore the relationship between depreciation rate and firm financing.

Eisfeldt and Rampini (2007) also examines the effect of financial constraints on the choice between new and used capital. They argue that used capital is cheaper upfront but has a higher maintenance cost, which can be paid by firms later. Cheaper upfront cost encourages financially constrained firms toward purchasing more used capital. However, durability plays no role in this analysis. Contrary to this finding, an empirical study by Baxamusa et al. (2016) finds that expectation about future technological changes is responsible behind constrained firms' choice of used assets.

The effect of financing frictions on firm investment has been extensively investigated in the corporate finance literature. Fazzari et al. (1988) argue that when external financing is more costly than internal financing, investment becomes more sensitive to changes in cash flow. To support their hypothesis, they report evidence that firms that pay low dividends display excess investment-cash flow sensitivity. Kaplan and Zingales (1997), however, challenge this finding. They argue that the relationship between investment-cash flow sensitivity and financial constraints depends on how firms are grouped into constrained and uncon-

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[4] Fraumeni (1997) provides a review of the literature on the estimation of depreciation rates.

strained types. Using multiple classification methods, they show, higher investment-cash flow sensitivity can also exist for firms that are classified as financially unconstrained. A similar argument is echoed by Erickson and Whited (2000) and Alti (2003) who identify Tobin's $Q$ as a noisy proxy of investment opportunity. They argue that if cash flow contains information about investment opportunity, then, investment by unconstrained firms can also display higher cash flow sensitivity. Tsoukalas (2011) shows that investment-cash flow sensitivity can be significant even in the absence of financial frictions when time-to-build and time-to-plan features for installation of capital is taken into consideration. Hovakimian (2009) employs a different approach to identify the relationship between investment-cash flow sensitivity and financial constraints. The author calculates investment-cash flow sensitivities at the firm level and classifies firms in groups with high, low, and negative cash flow sensitivity. Consistent with Fazzari et al. (1988), firms that are financially constrained appear to show significant cash flow sensitivity while unconstrained firms' investments do not exhibit sensitivity to internal funds. The paper also finds that among the constrained firms, those that are extremely constrained display negative investment-cash flow sensitivity. Constrained firms may also exhibit excess investment-cash flow sensitivity due to variables that facilitate financing (Almeida and Campello (2007)). Using firm-level data, Almeida and Campello (2007) show that for constrained firms, investment-cash flow sensitivity increases with tangibility. For unconstrained firms, however, they find no significant relationship between tangibility and investment-cash flow sensitivity.

Empirical estimation of financial constraints can be quite challenging as financial constraints are unobservable. Financial constraints are measured using various proxies in the literature. There is little consensus on which proxy provides the most accurate measure of financial constraints.

One strand of literature uses proxies for financial constraints based on one single variable that includes payout ratio, firm size, and the presence of credit rating (e.g., Almeida and Campello (2007), Gilchrist and Himmelberg (1995)). Firms that are smaller or have no credit rating or belong to the lower end of the payout distribution are classified as constrained. The opposite rules apply to unconstrained firms.

Another strand of literature uses indices based on firm-level characteristics as proxies for financial constraints (e.g.,Almeida et al. (2004), Baxamusa et al. (2016), Hadlock and Pierce (2010)). One popular measure of financial constraints is the Kaplan and Zingales (KZ) index. This measure stems from the above-discussed argument by Kaplan and Zingales (1997) proposed to challenge Fazzari et al. (1988) findings. But Lamont et al. (2001) constructs the actual KZ index. The authors follow the classification by Kaplan and Zingales (1997) and estimate an ordered logit model that relates financial constraints to five accounting variables: cash flow, market value, debt, dividends, and cash holdings each scaled by total assets. The index was created using the sample of 49 firms originally used by Fazzari et al. (1988). But the general convention in the literature is to use the Lamont et al. (2001) coefficients. Hadlock and Pierce (2010) update Kaplan and Zingales (1997) measure of financial constraints by including the annual reports of 356 randomly selected firms that identify themselves as financially constrained for the period of 1995-2004 to the initial sample. Their index of financial constraints is based on firm size, size squared, and firm age. Users of this index construct the index using the original coefficients by Hadlock and Pierce (2010) to their own sample. Whited and Wu (2006) follow a structural model based approach to construct an index of financial constraints. It represents the shadow price of raising equity capital or the Lagrange multiplier on the external finance constraints. Instead of re-estimating the structural model for own sample, the users of this index use the original coefficients to construct the index. One major drawback of all these index-based approaches is that they all are sample-based indices. Out of sample extrapolation may not always generate an accurate measure of financial constraints. In my paper I adopt both univariate proxy and index-based proxy of financial constraints.

Although previous studies have discussed separately the choice of optimal durability and the effect of financial constraints at length, prior work has not examined empirically how asset durability interacts with financial constraints and affects investment. My paper contributes to the literature by using depreciation rate as a measure of durability and explores the connection between asset durability and firm financing in the presence of financial constraints.

# 3 Theoretical background

Rampini (2019) develops a model with collateral constraints. The model assumes that the economy has limited enforcement and firms that default on debt obligations cannot be excluded from borrowing. Subject to collateral constraints, under complete market, firms in this economy can implement a dynamic contract one period ahead. Unlike previous models with collateral constraints (Kiyotaki and Moore (1997)), this model considers the effect of depreciation or durability of capital on the collateral constraints faced by firms. Capitals purchased by firms can either have different geometric depreciation rates or have a finite useful life. With the latter, new capital is more durable compared to used ones. For capital with geometric depreciation, the price is determined by the cost of producing the capital. In this paper, I only consider the case where capital has geometric depreciation.

### 3.1 Rampini (2019)

The model economy is set in discrete time with infinite horizon where t=0,1,2,.... The economy has a continuum of stochastic overlapping generations of entrepreneurs. The model is a stationary competitive general equilibrium model with production. The entrepreneur maximizes the value function subject to the budget constraint it faces in the current period and the next period along with a collateral constraint. There are two types of capital used for production and an output good which is a numeraire. Firms can choose between two types of capital which are perfect substitutes but have different durability (more durable and less durable). Let $\delta_i$ denote the depreciation rate of capital $i$ each period where, $i \in I \equiv [d\ (durable), nd\ (non\text{-}durable)]$ with $\delta_i \in (0,1)$ and $\delta_d < \delta_{nd}$. Then durability of capital $i$ is given by

$$D_i = 1 - \delta_i \tag{1}$$

Due to the presence of collateral constraints, a firm can borrow only up to a fraction $\vartheta \in [0,1)$ of the depreciated capital at interest rate $R$. If the price of capital $i$ is $q_i$ and $b$ is total borrowing, then the collateral constraint is given by,

$$\vartheta \sum_{i \in I} q_i k_i (1 - \delta_i) \geq Rb \tag{2}$$

The collateral constraint implies that including the interest payment, the firm can borrow up to a fraction $\vartheta$ of the resale value of the depreciated capital. The model characterizes that trade-off between more or less durable capital depends on the frictionless user cost of capital and the down payment. The frictionless user cost (one period rental rate) of capital $i$ is defined following Jorgenson (1963) as,

$$u_i \equiv R^{-1} q_i (r + \delta_i) \tag{3}$$

Where, $r$ is the interest payment made for financing one unit of capital $i$. If the price of one unit of type $i$ capital is $q_i$ and firms can obtain only a fraction of the cost of capital $R^{-1}\vartheta q_i(1 - \delta_i)$ through financing, then the difference must be put as down-payment.

If down-payment required for one unit of capital is $\Psi_i$ then the price of capital,

$$q_i = \Psi_i + b_i \tag{4}$$

where, $b_i = R^{-1}\vartheta q_i(1-\delta_i)$ is the present value of borrowing for 1 unit of capital $i$.

Using the definition of user cost in (3) the model shows that down-payment is the summation of frictionless user cost of capital $u_i$ and the present value of the resale value of non-pledgeable amount of capital. Thus,

$$\Psi_i = u_i + \eta_i \tag{5}$$

where, $\eta_i = R^{-1}(1-\vartheta)q_i(1-\delta_i)$ is the present value of the non-pledgeable resale value of the assets purchased. As the residual value of capital is only partially pledgeable, the financing need exceeds the frictionless user cost.

The model shows that when the collateral constraint binds, the discounted marginal product of capital equals the frictionless user cost plus a penalty for the down payment.[5] Thus, with the presence of collateral constraints investment is determined by the user cost as well as the down payment.

The choice of durability, therefore, depends not only on the user cost but also on the down payment of capital. In equilibrium, when the firm uses both types of capital, then neither type is dominated by the other. For capital of type $i$ and $i'$ with $i \neq i'$, suppose, $u_i > u_{i'}$ and $\Psi_i > \Psi_{i'}$. The first-order condition for the entrepreneur then implies that $f_k(k_i) > f_k(k_{i'})$ where, $f_k$ is the marginal productivity of capital i.e. type $i$ capital is dominated. Thus if type $i$ capital has a higher user cost and if (in equilibrium) neither type of capital is dominated then it must be that $f_k(k_i) = f_k(k_{i'})$ and also, $\Psi_i < \Psi_{i'}$ i.e. type $i$ capital must have a lower down payment.

For more durable and less durable capital respectively, suppose, $u_d > u_{nd}$; then from (3) this implies $R^{-1}q_d(r+\delta_d) > R^{-1}q_{nd}(r+\delta_{nd})$. As $\delta_d < \delta_{nd}$ then it must be that $q_d > q_{nd}$. Equation (5) thus implies $\Psi_d \equiv u_d + R^{-1}(1-\vartheta)q_d(1-\delta_d) > u_{nd} + R^{-1}(1-\vartheta)q_{nd}(1-\delta_{nd}) \equiv \Psi_{nd}$. Then it must be that the durable capital is dominated, which is a contradiction. Hence, in equilibrium, if a firm uses both more and less durable capital, then it must be that, $u_d < u_{nd}$ and $\Psi_d > \Psi_{nd}$ i.e. more durable capital has a lower user cost and a higher down

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[5] Rampini (2019) provides detailed proof of the entrepreneur's problem. The model shows that when $k_i > 0$, the first order conditions for capital $k_i$, $i \in I$ reduces to $u_i + \rho\Psi_i = \beta A f_k(k)$ where, $\rho$ is the penalty factor, $Af_k(k)$ is the marginal product of capital and $\beta$ is the discount rate.

payment compared to less durable capital. Thus equation (4) implies, $q_d(1-R^{-1}\vartheta(1-\delta_d)) > q_{nd}(1-R^{-1}\vartheta(1-\delta_{nd}))$. Therefore, $q_d > q_{nd}$; more durable capital is more expensive compared to less durable capital. The theoretical model leads to the following prediction:

**Trade off between user cost and down-payment:** If two types of capital are perfect substitutes in production and have different depreciation rates $\delta_d < \delta_{nd}$, then in equilibrium more (less) durable capital has a lower (higher) user cost ($u_d < u_{nd}$). However, more (less) durable capital must require a higher (lower) down-payment ($\Psi_d > \Psi_{nd}$) due to their higher (lower) resale value. The higher down-payment of more durable capital makes them harder to finance.

The model further shows that the user cost of capital $i$ as a function of net worth ($\omega$) can be expressed as

$$u_i(\omega) = u_i + \beta\frac{\lambda'}{\mu}(1-\vartheta)q_i(1-\delta_i) \tag{6}$$

where, $\lambda'$ is the multiplier on the collateral constraint and $\mu$ is the multiplier on the current period budget constraint. For unconstrained firms, $\lambda' = 0$ as they are unaffected by the collateral constraint. Thus, for unconstrained firms $u_i(\omega) \to u_i$, the frictionless user cost. Again, the user cost can also be expressed in the following way,

$$u_i(\omega) = \Psi_i - \beta\frac{\mu'}{\mu}(1-\vartheta)q_i(1-\delta_i) \tag{7}$$

where, $\mu'$ is the multiplier on the next period budget constraint. For severely constrained firms $\omega$ goes to 0 and so does investment. As a result, $\beta\frac{\mu'}{\mu} = 0$. Thus for severely constrained firms $u_i(\omega) \to \Psi_i$, the down-payment. Thus the composition of investment according to the financial position of a firm can be summarized as follows:

**Choice of durability and the composition of investment:** In equilibrium if both types of capital are used then the model shows that unconstrained firms make their optimal choice between two types of capital by comparing their frictionless user costs. Since user costs are lower for more durable capital ($u_d < u_{nd}$), unconstrained firms optimally choose more durable capital. By contrast, severely constrained firms make their optimal choice of capital based on down-payment. Hence, in equilibrium, severely constrained firms optimally choose less durable capital as they involve less financing.

### 3.2 Testable hypotheses

As firms may find it difficult to invest in more durable assets through external financing due to the higher price of durable assets, I test my first hypothesis as following:

**Hypothesis 1:** Increased durability increases the cost of external financing for financially constrained firms. For financially unconstrained firms durability has no effect on their financial constraints.

Again, as durable assets are harder to finance, then based on the predictions in Rampini (2019), the more (less) financially constrained firms will choose to invest in less (more) durable assets. Therefore, I test the second hypothesis as follows:

**Hypothesis 2:** If firms endogenously choose durability of asset then asset durability decreases (increases) with the increase (decrease) in the financial constraints of a firm.

## 4 Empirical analysis

In light of the hypotheses stated above the empirical approach adopted in my paper discusses if durability of new investment affects cost of external financing and whether the choice of durability is driven by the financial constraints faced by a firm. There is no consensus in the literature on any single correct way of measuring financial constraints. One strand of research uses proxies for financial constraints based on a single variable that includes payout ratio, firm size, and the presence of credit rating. Another strand of literature uses proxies for financial constraints based on indices generated from firm-specific financial status. In my empirical analysis, I use both types of proxies to measure financial constraints. For my empirical analysis I adopt two separate specifications based on the financial constraints literature. In this section, I provide a detailed empirical approach by describing data used for estimation, empirical specifications, and the results.

### 4.1 Data

My sample selection closely follows the literature (Almeida et al. (2004) and Almeida and Campello (2007)). I consider the sample of manufacturing firms (SIC 2000-3999) over 1983−2017. The sample consists of firm-level annual data on total asset, market capitalization, capital stock, cash flow and capital expenditures from COMPUSTAT. There are a number of standard steps in bringing this data to proposed analysis. First, I eliminate firm-year observations for which total assets (item AT), physical capital (item PPEGT) and sales (item

SALE) is either zero or negative. Next, following literature (Almeida and Campello (2007), Gilchrist and Himmelberg (1995)) I eliminate firm-year observations for which capital stock (item PPENT) is less than \$5 million. This strategy eliminates firms that are too small for a linear investment model to be applicable. I also eliminate firm-years for which real asset or sales growth exceed 100% as these large increases are likely due to mergers and acquisitions. Then, following the model, I eliminate firm-year observations for which depreciation rate is negative, zero or greater than 1 ($0 < \delta_i < 1$). Finally, I eliminate firm-year observations with negative $Q$ or with $Q$ greater than 10 to reduce the impact of mismeasurement of $Q$ on the fitness of investment model.[6] I deflate all series to 2010 dollars using CPI data retrieved from the Bureau of Labor Statistics.

Following Almeida and Campello (2007), I keep those firms that appear for at least three consecutive years in the data. This is the minimum number of years required for firms to enter in the estimation process given the lag structure of the regression model. Loss of observations from each elimination criterion is given in Table A1. The final sample consists of 2,795 firms and 37,944 firm-year observations.

For industry level analysis I use the capital stock of private non-residential fixed assets data and implied depreciation rate data from the Bureau of Economic Analysis for the same sample period.

## 4.2 The Measure of durability

Following Rampini (2019), I link the durability of an asset with its depreciation rate. For any firm $i$, durability $D_{i,t} = 1 - \delta_{i,t}$ where, $\delta_{i,t}$ is the depreciation rate of assets used by firm $i$ at time $t$. The higher the depreciation, the less durable the asset is and vice versa. It is natural to use the economic depreciation rate for the analysis, but data on the composition of physical capital is unavailable at the firm level. Given this data constraint I use industry-level data on implied depreciation rate of physical capital retrieved from BEA, to examine the relationship between the durability of physical capital with the share of structures, equipment, and intellectual property for the manufacturing industry. Figure 1 shows that the share of structure in physical capital ranges from as low as 26% (chemical products) to as high as 60% (apparel products). Looking at Figure 2 it appears that the sector that has the

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[6] These same cut-off points for $Q$ have been used by Almeida and Campello (2007) and Gilchrist and Himmelberg (1995). The average value of $Q$ in the sample used for this study is slightly higher than 1 which is very close to the average $Q$ reported by the studies that do not use these cut-offs (Kaplan and Zingales (1997) report average $Q$ of 1.2 and Polk and Sapienza (2004) report average $Q$ of 1.6).

highest durability of physical assets may not have the highest share of structures in physical capital. However, the pairwise correlation coefficient between the share of structures and durability is positive (0.65) and significant at the 5% level. This implies that industries that use more structures show up having higher durability of capital.

I conduct a firm level analysis using a proxy for economic depreciation rate. Following Chen (2014), I calculate the implied depreciation rate for each firm using the following expression:

$$\delta_{i,t} = \left[ \frac{i_{i,t-1}}{k_{i,t-1}} + \frac{k_{i,t-1}}{k_{i,t}} - 1 \right] \tag{8}$$

where $k_{i,t}$ is the book value of physical assets (item #7 PPEGT) and $i_{i,t}$ is calculated as capital expenditures(item #128 CAPX) minus sale of property, plant, and equipment (item #107 SPPE). To check the consistency of these depreciation rates, I group the sample of firms with depreciation rate $0 \leq \delta_i \leq 1$ into 17 industries using classification scheme of Fama and French (1997) and calculate the mean of $\delta_i$ for each industry (see Table A2). The depreciation rate ranges from 6.4% for the steel industry to 10% for the construction industry. I also calculate the implied depreciation rates at the 3-digit level for the manufacturing industry by grouping firms according to the North American Industry Classification System (NAICS). Figure 3 provides a comparison of the estimates from the sample and the BEA estimates for the same time period. While for some sub-sectors, the estimates are very similar (e.g., food, fabricated metals, and primary metals), for others like textile, automobile, and computers, the estimates differ substantially. For the rest of the sub-sectors, the estimates are relatively similar. One probable reason the rates calculated from the sample do not exactly match the rates obtained from BEA is that the sample in this analysis consists only of listed firms and no private firms. However, the BEA rates are constructed using data on both private and listed firms.

A potential weakness of this approach is that it provides a measure for depreciation of assets already in place, while the propositions generated by the model relate depreciation of assets to new investment. The lack of availability of data prevents gathering more information on types of assets firms purchase with marginal dollar investment. However, if firms continue to buy new assets that are similar to the kind of assets already in place, then the depreciation rates of new and existing assets are similar. In this case, depreciation rates of existing assets will remain a good proxy for depreciation rates of new investments.

## 4.3 Durability of new investment and external financing cost

To investigate how asset durability affects the cost of external financing for firms I augment the investment model in Fazzari et al. (1988) to include asset durability ($D$) and also an interaction term between cash flow and durability ($CF \times D$).[7] The interaction term captures the effect of durability on cash flow sensitivity of investment. The empirical model is written as:

$$I_{i,t} = \alpha_1 Q_{i,t-1} + \alpha_2 CF_{i,t} + \alpha_3 D_{i,t} + \alpha_4 (CF \times D)_{i,t} + \sum_i firm_i + \sum_t year_t + \epsilon_{i,t} \qquad (9)$$

where, $D_{i,t}$ is the durability of assets, $CF_{i,t}$ is the cash flow of firm $i$ at time $t$. $Q_{i,t}$ is the Tobin's $Q$ for firm $i$ at time $t$. $Q$ is the ratio of the market value of total assets of a firm over the replacement value of its assets and enters the model as a proxy for investment opportunity. Finally, firm and year capture firm- and year- specific fixed effects.[8]

The coefficient of the interaction term ($\alpha_4$) captures the effect of durability on firms' financing capacity. According to hypothesis 1, if durability increases the cost of financing for constrained firms, then the extent to which a firm's investment is sensitive to internal funds should be an increasing function of durability (i.e. $\alpha_4$ must be positive). However, the interaction term alone is not informative of the net effect that durability has on firm investment with financial constraints present. Since the empirical investment model contains an interaction term, the partial effect of cash flow on investment is given by $\alpha_2 + \alpha_4 \times D$.

### 4.3.1 Constraint selection

For this analysis I use proxies for financial constraints based on a single variable. I use several ex-ante constraint selection schemes to distinguish financially constrained and unconstrained firms. I follow the standard approach in the literature (Fazzari et al. (1988), Almeida et al. (2004), Almeida and Campello (2007), Denis and Sibilkov (2009)) to classify firms into financially constrained and unconstrained groups. After separating the sample into subsamples of constrained and unconstrained firms, I estimate equation (9) for each regime under each criterion. I apply the following schemes to sort the sample:

**1. *Annual payout ratio***: In every year over the 1983-2017 period, I rank firms based on their payout ratio. Financially constrained (unconstrained) firms are those that belong in the

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[7] The empirical modification of the investment equation closely resembles Almeida and Campello (2007) where the authors included tangibility as an interaction term.

[8] Definitions of the variables are provided in the appendix.

bottom (top) three deciles of annual payout distribution. The intuition behind this scheme is that financially constrained firms typically have lower payouts (Fazzari et al. (1988)). The payout ratio is computed as the ratio of dividends and common stock repurchases to operating income.[9]

**2. *Firm size***: In every year over the 1983-2017 period I rank firms based on their total assets. Financially constrained (unconstrained) firms are those that belong in the bottom (top) three deciles of asset distribution. This scheme is based on the idea that, smaller firms are relatively young and more vulnerable to credit market frictions. This approach resembles the work of Gilchrist and Himmelberg (1995), Erickson and Whited (2000), Almeida et al. (2004) among others.

**3. *Debt Rating***: Following Whited (1992), Gilchrist and Himmelberg (1995)), and Almeida et al. (2004) I retrieve data on firms' bond ratings.[10] Firms that have had their long-term debt rated by Standard & Poor's, and their debt is not at default (rating of "D" or "SD") are categorized as unconstrained. Firms that never had their public debt rated are categorized to be constrained. Firms with no debt outstanding and no debt rating are classified as unconstrained.

**4. *Commercial Paper Rating***: I construct a similar criterion like debt rating by retrieving data on S&P short-term debt rating. Firms are classified as constrained if they never had their issues rated and report positive debt. Firms that had their issues rated at any point of time during the sample period are classified as unconstrained. Calomiris and Hubbard (1995) follow this approach of classifying firms into constrained and unconstrained groups.

### 4.3.2 Durability and cash flow sensitivity of investment

I first report the summary statistics for durability and other key variables in Table 1 and 2. I follow standard financial constraints literature for sample selection and variable construction. As durability is the central variable of interest in this study, the descriptive statistics as well as discussion on key findings revolve around that variable. Mean durability for all the firms in the sample is about 91.6% which implies that on average the physical capital of a firm depreciates at 8.4% per year. The variation in the durability of assets ranges from 0.90 for

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[9] The deciles set using payout distribution generate a different number of observations assigned to each decile. This approach ensures that firms with lower payout ratios are assigned constrained group while firms with the same payout ratios are assigned to the same group. The minimum payout ratio for unconstrained firms is 0.35 which is greater than the maximum payout ratio for constrained firms (0.14).

[10] S&P Long-term debt ratings are available on COMPUSTAT

the first quartile of firms to 0.987 for the third quartile. Low standard deviation of durability in the sample implies that the variation in the durability of assets in my sample is not very high.

Table 1: Summary statistics for durability

|  | Mean | Median | Std. Dev | Pct. 5 | Pct. 25 | Pct. 75 | Pct. 95 | N |
|---|---|---|---|---|---|---|---|---|
| Full Sample | 0.916 | 0.941 | 0.090 | 0.77 | 0.90 | 0.963 | 0.987 | 37,944 |

This table gives summary statistics for durability. Durability is measured as $1-\delta_i$ where $\delta_i$ is the depreciation rate of physical assets used by firm $i$. The sample includes manufacturing firms only (SICs 2000-3999) and the sample period is 1983-2017.

Table 2 reports the sample characteristics of firms with highly durable assets and less durable assets. High durability firms (with mean durability 0.933) are those firms in the top three deciles of durability distribution and low durability firms (with mean durability 0.889) are those firms in the bottom three deciles of durability distribution. Firms using highly durable assets have a higher investment/capital ratio as well as higher cash flow compared to firms using less durable assets. Firms using highly durable assets seem to display characteristics similar to that of unconstrained firms as unconstrained firms typically have higher investment/capital ratio and cash flow compared to firms which are financially constrained (Fazzari et al. (1988)). The mean value of Q is similar for both types of firms. The resemblance of sample characteristics between high durability (low durability) firms to that of unconstrained (constrained) firms further motivates to examine how asset durability affects firm financing.

Table 2: Descriptive statistics of key variables

|  | Investment |  |  | Q |  |  | Cash flow |  |  | N |
|---|---|---|---|---|---|---|---|---|---|---|
|  | Mean | Median | Std. Dev | Mean | Median | Std. Dev | Mean | Median | Std. Dev |  |
| High durability | 0.306 | 0.239 | 0.253 | 1.21 | 1.03 | 0.701 | 0.489 | 0.397 | 1.07 | 8,151 |
| Low durability | 0.188 | 0.156 | 0.138 | 1.15 | 1.00 | 0.635 | 0.245 | 0.250 | 1.024 | 8,109 |

This table displays summary statistics for investment, Q and cash flow for high durable asset firms and low durable asset firms where high durability (low durability) firms are those firms in the top (bottom) three deciles of durability distribution.

Table 3 displays the regression results for the model of investment (equation 9), which includes an interaction term between cash flow and durability. I estimate the equation using OLS with firm- and year- fixed effects. The table reports a total of eight regression results (4 constraint criteria × 2 constraint categories). The results indicate that for each constraint criterion, investment-cash flow sensitivity is increasing in durability for constrained firms. By contrast, for unconstrained firms, investment-cash flow sensitivity becomes unresponsive to an increase in the durability of assets under two out of the four constraint criteria.

Table 3: Regression Results: Durability and external finance

| Dependent Variable | | Independent Variables | | | |
|---|---|---|---|---|---|
| Investment | $N$ | $Q$ | $CF$ | $D$ | $CF \times D$ |
| 1. **Payout policy** | | | | | |
| Constrained | 9,646 | 0.084** | -0.051** | 0.166** | 0.077** |
| | | (8.83) | (-3.15) | (8.31) | (4.22) |
| Unconstrained | 9,091 | 0.044*** | -0.091** | 0.125** | 0.134** |
| | | (8.11) | (-2.23) | (5.64) | (3.01) |
| 2. **Asset size** | | | | | |
| Constrained | 8,577 | 0.063** | -0.071** | 0.204** | 0.104** |
| | | (6.93) | (-3.23) | (6.95) | (4.22) |
| Unconstrained | 7,416 | 0.064** | 0.008 | 0.135** | 0.033 |
| | | (7.85) | (0.28) | (7.52) | (1.04) |
| 3. **Bond rating** | | | | | |
| Constrained | 9,596 | 0.063** | -0.034 | 0.123** | 0.109** |
| | | (7.88) | (-1.23) | (6.30) | (3.50) |
| Unconstrained | 5,322 | 0.040** | 0.015 | 0.115** | 0.038 |
| | | (7.40) | (0.61) | (8.55) | (1.57) |
| 4. **CP Rating** | | | | | |
| Constrained | 12,068 | 0.061** | -0.013 | 0.119** | 0.083** |
| | | (8.86) | (-0.59) | (7.87) | (3.57) |
| Unconstrained | 2,850 | 0.018** | -0.146** | 0.058** | 0.216** |
| | | (4.62) | (-2.15) | (2.40) | (3.01) |
| 5. **Full Sample** | 27,129 | 0.068** | -0.016 | 0.164** | 0.052** |
| | | (15.02) | (-0.86) | (13.09) | (2.73) |

This table presents the results for OLS-FE (firm and year effects) regression of investment. The results are based on priori selection criteria that distinguish between 'constrained' and 'unconstrained' firms. White-Hubar estimator is used to correct for heteroskedasticity and clustering. The t-scores are reported in parenthesis. ** and * are used to indicate significance at 1% and 5% level respectively.

The coefficients of the interaction term for constrained firms are higher than that of unconstrained firms when firms are sorted according to their size and bond rating. However, these differences in the coefficients across samples of constrained and unconstrained firms are not statistically significant.[11] Durability positively affects investment-cash flow sensitivity for unconstrained firms when firms are sorted into constrained and unconstrained classes according to their payout distribution or commercial paper rating.

Notice that the coefficient on cash flow for constrained firms under each constraint criterion is negative in the majority of the regressions. However, this negative sign is not indicative of lower investment due to higher cash flow. These coefficients are not informative unless they are combined with coefficients of the interaction term. Higher cash flow will only generate lower investment if durability is extremely low or depreciation rate is very high.[12] This is consistent with the findings of Hovakimian (2009). Thus, firms having assets with high depreciation rates are extremely constrained.

For constrained firms classified according to the asset distribution, the partial effect of one standard deviation (1.02) increase in cash flow with very low asset durability (0.77 at 5th percentile) is 0.009. At high asset durability (0.99 at 95th percentile) the partial effect of cash flow is 0.03.[13] Thus, with a 2.2% increase in durability, investment-cash flow sensitivity increases by a small (0.021) amount. As asset durability increases, constrained firms find it difficult to obtain external financing, which makes these firms more reliant on internal financing for marginal investments.

For firms classified as unconstrained according to their payout distribution or short-term credit ratings, coefficients of cash flow, and the interaction term, both are statistically significant. These firms will face a higher cost of financing new investments through external financing with an increase in durability. However, for firms classified as unconstrained according to their asset distribution or bond ratings, coefficients of cash flow, and the interaction term, both are statistically insignificant. Thus, investment by these firms is not affected by internal cash flow. Again, a positive and significant coefficient of asset durability implies that these unconstrained firms invest more in more durable assets.

The coefficients of $Q$ are positive and statistically significant across constrained and unconstrained firms. Notice that coefficients of $Q$ are slightly higher for constrained firms

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[11] The p-value associated with the $\chi^2$ test is 0.11 for firms classified according to total assets and the p-value associated with the $\chi^2$ test is 0.19 for firms classified according to bond rating.

[12] The partial effect of cash flow on investment to capital ratio is negative if the depreciation rate is as high as 35%.

[13] The partial effect of cash flow on investment is equal to the summation of the standard deviation of cash flows times the coefficient of cash flow and the same standard deviation times the coefficient of the interaction term times the level of durability (5 percentile value and 95 percentile value).

compared to unconstrained firms in three out of the four constraint selection criteria (with only one exception of constraint selection criterion - asset size). This implies, that the increase in investment opportunity induces more investment for firms that are more financially constrained. This pattern is consistent with the previous literature (Fazzari et al. (1988), Hoshi et al. (1991) and Cummins et al. (1999))

Finally, with no sample separation, durability is found to increase investment-cash flow sensitivity. This implies that durability on average increases the cost of external finance for the firms considered in this sample.

### 4.3.3 Measurement error in Q and sensitivity to outliers

I subject the above findings to a few robustness checks. The use of $Q$ as a proxy for investment opportunity in the investment equation is a highly debatable topic in the literature. Noted works in the literature (Cummins et al. (1999), Erickson and Whited (2000), Gomes (2001), and Alti (2003)) argue that measurement error associated with $Q$ can produce biased estimates of investment-cash flow sensitivities particularly for firms that are typically classified as financially constrained. Due mismeasurement of $Q$, cash flow might contain information of investment opprtunities in the investment regression. Thus, significant investment-cash flow sensitivity can be found for constrained firms even in the absence of financial constraints due to this proxy quality problem associated with $Q$. To eliminate the potential bias in my estimates associated with the measurement error in $Q$, I estimate the Euler-type investment model proposed by Bond and Meghir (1994). The authors study the investment behavior of firms based on the Euler equation of an adjustment cost model. Following Bond and Meghir (1994) I add lagged investment to capital ratio, its squared, lagged sales to capital ratio, its squared and lagged debt to capital ratio to the set of regressors.[14] To estimate this dynamic panel data model of investment, I use a two-step dynamic panel GMM estimation proposed by Arellano and Bond (1991). The respective lagged values serve as instruments for the differenced regressors in these regressions.

Table 4 reports the estimates of the coefficients of only the key variable of interest, i.e., the interaction term between cash flow and durability. For constrained firms, the coefficient of the interaction term is positive and significant across all constraint selection category. This result is similar to what I found for the OLS estimation for constrained firms. Hence, increased durability increases investment-cash flow sensitivity for financially constrained firms.

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[14] Almeida and Campello (2007) use this approach to address the issue of measurement error in $Q$ as a proxy for investment opportunities.

Table 4: Measurement error in $Q$

| | Payout ratio | Asset size | Bond rating | CP rating |
|---|---|---|---|---|
| | 0.088* | 0.120** | 0.175** | 0.128** |
| Constrained firms | (3.78) | (2.42) | (2.59) | (3.63) |
| | [0.557] | [0.389] | [0.042] | [0.378] |
| | 0.096 | 0.066 | 0.027 | 0.305** |
| Unconstrained firms | (1.53) | (1.15) | (1.23) | (4.17) |
| | [0.868] | [0.654] | [0.587] | [0.542] |

This table reports the GMM estimates of the coefficients returned for the interaction term $CF \times D$ following Bond and Meghir (1994), where $Q$ is eliminated as proxy for investment opportunity in the baseline model and the lags of investment, sales and debt are added as controls as well as instrumented. All regressions control for firm and year fixed effects. Heteroskedasticity and clustering correct standard errors are reported in the parenthesis. $P$-values associated with Hansen's $J$ statistic are reported in square brackets. ** and * indicate statistical significance at 1% and 5% level of significance respectively.

On the contrary, for unconstrained firms, the coefficients of the same variable are all statistically not significant except for firms classified according to their commercial paper rating. Durability does not affect the external cost of financing for firms that are classified as financially unconstrained based on their payout distribution or asset distribution or bond ratings. The advantage of this approach is that this approach altogether replaces $Q$ with other regressors. The absence of $Q$ from the regressions eliminates the possibility of getting biased estimates due to measurement error associated with the estimation of $Q$.

I also winsorize the data from both ends at extreme percentiles to mitigate the effect of outliers present in the sample. Table 5 reports the estimates for the coefficients of the interaction term between cash flow and durability from the OLS regression at different winsorization thresholds.

Panels A and B of table 5 reports the estimates at different winsorization cut-offs. In both cases, durability continues to have a positive and significant effect on cash-flow sensitivity of investment for constrained firms regardless of the constraint selection criterion. For unconstrained firms, increased durability increases the cost of external funding when firms are sorted according to their payout distribution, asset distribution, or bond ratings. However, durability has no significant effect on cash-flow sensitivity of investment for firms classified as unconstrained using sort-term credit rating as a proxy for financial constraint. These findings are in contrast to those I obtained from OLS estimation of equation (9) with non-winsorized data. Coefficients from OLS estimation thus demonstrate significant sensitivity to winsorization thresholds chosen i.e. they remain sensitive to outliers.

Table 5: Outlier treatment

| | A. Winsorization cut-off 2% and 98% | | | |
|---|---|---|---|---|
| | Payout ratio | Asset size | Bond rating | CP rating |
| Constrained firms | 0.159* | 0.194** | 0.319** | 0.263** |
| | (8.57) | (7.72) | (11.14) | (8.92) |
| Unconstrained firms | 0.154** | 0.104* | 0.107* | 0.102 |
| | (4.79) | (2.35) | (1.99) | (1.40) |

| | B. Winsorization cut-off 1% and 99% | | | |
|---|---|---|---|---|
| | Payout ratio | Asset size | Bond rating | CP rating |
| Constrained firms | 0.116** | 0.135** | 0.278** | 0.236** |
| | (5.47) | (4.94) | (10.09) | (9.44) |
| Unconstrained firms | 0.118** | 0.108** | 0.126** | 0.155 |
| | (3.78) | (2.83) | (2.68) | (1.92) |

This table reports the OLS estimates of the coefficients returned for the interaction term $CF \times D$ after estimating equation (7) with data treated for outliers by winsorizing at different cut-off points. All regressions control for firm and year fixed effects. Heteroskedasticity and clustering corrected standard errors are reported in the parenthesis. ** and * indicate statistical significance at 1% and 5% level of significance respectively.

To check if GMM estimates also demonstrate similar sensitivity to outliers I also estimate the Euler-type investment model by Bond and Meghir (1994) for winsorized data. Table 6 reports the coefficients from GMM estimation using winsorized data with cut-off set at 1% and 99%. The estimates from GMM estimation also show sensitivity to outlier treatment.

Table 6: Measurement error in Q and outlier treatment

| | Payout ratio | Asset size | Bond rating | CP rating |
|---|---|---|---|---|
| Constrained firms | 0.11** | 0.134* | 0.395** | 0.30** |
| | (4.73) | (2.54) | (9.77) | (9.29) |
| | [0.586] | [0.630] | [0.423] | [0.517] |
| Unconstrained firms | 0.094 | 0.174** | 0.208** | 0.287** |
| | (1.43) | (4.07) | (5.01) | (4.10) |
| | [0.771] | [0.575] | [0.462] | [0.243] |

This table reports the GMM estimates of the coefficients returned for the interaction term $CF \times D$ following Bond and Meghir (1994), where $Q$ is eliminated as a proxy for investment opportunity in the baseline model and the lags of investment, sales and debt are added as controls as well as instrumented. The data is winsorized using cut-offs of 1% and 99%. All regressions control for firm and year fixed effects. Heteroskedasticity and clustering correct standard errors are reported in the parenthesis. $P$-values associated with Hansen's $J$ statistic are reported in square brackets. ** and * indicate statistical significance at 1% and 5% level of significance respectively.

The results show that the GMM estimates also demonstrate high sensitivity to outlier treatment. Thus, presence of outliers remains a concern even after controlling for the measurement error in $Q$ and the endogeneity. The findings overall suggest that when firms invest in tangible physical assets, increased durability of assets increases external financing costs (as reflected by increased sensitivity of investment to changes in cash flow) for firms that are already financially constrained. On the contrary, for unconstrained firms effect of durability on financing remains ambiguous.

## 4.4 Choice of durability and financial constraints

From the above discussion of empirical findings I find some support in favor of hypothesis 1. To further investigate if firms choose the level of durability depending on their financial constraints, I model durability ($D$) as a function of firms' financial constraints and some firm-specific controls. The empirical model used in this approach is follows

$$D_{i,t} = \beta_1 + \beta_2 FC_{i,t} + \gamma X_{i,t} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t} \tag{10}$$

In this specification, $D_{i,t}$ is the durability of assets of firm $i$ at time $t$. To measure financial constraints ($FC_{i,t}$), I employ the index based proxies for financial constraints. The coefficient $\beta_2$ captures how asset durability is affected by the change in a firm's financial constraints. A negative value of $\beta_2$ implies that firms invest in less durable assets as they become more financially constrained, in line with hypothesis 1. $X_{i,t}$ is a vector of all firm-specific controls, which include $Q$ (proxy for investment opportunity), cash flow, size, return on assets (ROA), and leverage. I include these controls following the previous literature. $firm_i$ and $year_t$ are firm- and year- fixed effects.

### 4.4.1 Constraint selection

To estimate equation (10) I use proxies of financial constraints based on commonly used indices of financial constraints namely, the KZ index, the WW index and the HP index. Below I describe the construction of the indices and the variables used.

**The KZ index**: I follow Lamont et al. (2001) to construct the index as, kz $= -1.001909[$ $(ib + dp)/$lagged $ppent] + 0.2826389[$ $(at + prcc_f \times csho$ - $ceq$ - $txdb)/at] + 3.139193[(dltt + dlc)/(dltt + dlc + seq)] - 39.3678[(dvc + dvp)/$lagged $ppent]$ - $1.314759[che/$lagged $ppent]$, where, all the variables in italics are Compustat items. Lamont et al. (2001) estimate an ordered logit model that measure the degree of financial constraints using five variables reflective of a firm's financial status namely, cash flow, market value, debt, dividends, and cash holdings.

**The WW index**: Following Whited and Wu (2006) and Hennessy and Whited (2007) I construct the index as, $\text{ww} = -0.091\ [(ib + dp)/at] - 0.062[\text{dividend}] + 0.021[dltt/at] - 0.044[\log(at)] + 0.102[\text{isg}] - 0.035[\text{sg}]$, where, dividend is an indicator variable that takes the value of 1 if $(dvc+dvp)$ is positive and 0 otherwise, sg is sales growth and isg is industry sales growth rate which is the estimated separately for 3-digit SIC industry. This index is derived using the coefficients obtained from a structural model. It represents the shadow price of raising equity capital or the Lagrange multiplier on the external financial constraints.

**The HP index**: Following Hadlock and Pierce (2010) I construct the index as, $\text{hp} = -0.737[\text{Size}] + 0.043[\text{Size}^2] - 0.040[\text{Age}]$, where, Size is the natural logarithm of inflation adjusted total assets (Compustat item *at*) and Age is the number of years the firm is listed with a non-missing stock-price on Compustat. Following Hadlock and Pierce (2010) I cap the size at $4.5 billion and age at 37 years.

I follow standard convention in the literature to winsorize the top and bottom 1% of the data. Table (7) provides the summary statistics of the financial constraints indices. It appears from the standard deviation of the indices that compared to the WW index and the HP index, there is more variability in the level of financial constraints of firms when the KZ index measures financial constraints.

Table 7: Summary statistics for measures of financial constraints

| Measures of financial constraints | Mean | Std. Dev | No of Observations |
|---|---|---|---|
| KZ index | -2.88 | 6.539 | 37,486 |
| WW index | -.295 | 0.102 | 34,230 |
| HP index | -3.14 | 0.471 | 37,731 |

This table provides summary statistics for three index based proxies of financial constraints namely, the KZ index, the WW index and the HP index. I winsorized the data at 1% and 99% before constructing the indices.

From Table (8), I find that all three financial constraints measures positively correlate at the 1% level of significance. The KZ index weakly correlates with the WW index and the HP index. Again, the WW index and the HP index share moderate correlation. The departure of the KZ index from the WW index and the HP index in separating the financially constrained firms from the unconstrained ones is well documented in the literature (Farre-Mensa and

Ljungqvist (2016)).[15] Except for firm leverage, all other firm-level control variables share a statistically significant negative correlation with all three financial constraints indices. These correlations are consistent, as firms with lower cash flows and smaller sizes are typically financially constrained. Durability is negatively correlated with all three measures of financial constraints, indicating support for hypothesis 2.

Table 8: Correlations among the variables

| Variables | KZ index | WW index | HP index | Durability ($D$) | $Q$ | cash flow | size | ROA | leverage |
|---|---|---|---|---|---|---|---|---|---|
| KZ index | 1.0000 | | | | | | | | |
| WW index | 0.2404*** | 1.0000 | | | | | | | |
| HP index | 0.1346*** | 0.5669*** | 1.0000 | | | | | | |
| Durability ($D$) | -0.0628*** | -0.0923*** | -0.0861*** | 1.0000 | | | | | |
| $Q$ | -0.1877*** | -0.1135*** | -0.0549*** | 0.0320*** | 1.0000 | | | | |
| cash flow | -0.4590*** | -0.2450*** | -0.1719*** | 0.1507*** | 0.1618*** | 1.0000 | | | |
| size | -0.1494*** | -0.9439*** | -0.5262*** | 0.0357*** | 0.0737*** | 0.1474*** | 1.0000 | | |
| roa | -0.2034*** | -0.3435*** | -0.2757*** | 0.1592*** | 0.2701*** | 0.6030*** | 0.1986*** | 1.0000 | |
| leverage | 0.3008*** | -0.0767*** | 0.0219*** | -0.0841*** | 0.0120** | -0.2337*** | 0.1684*** | -0.1211*** | 1.0000 |

This table provides the correlation coefficients among the key variables. ***, **, and * denote 1%, 5%, and 10% level of significance respectively.

### 4.4.2 Does choice of durability depend on financial constraints?

Table 9 provides results for the estimation of the regression given by equation (10). Panel A reports the OLS estimation results of the regression. The estimations correct the standard errors for heteroskedasticity and clustering using the White-Huber sandwich estimator.[16] The results indicate a statistically significant negative relationship between financial constraints index and durability. A higher value of the financial constraints index indicates a higher cost of obtaining external finance. Hence, the negative coefficient of financial constraints implies that the durability of capital decreases as firms become more financially constrained. The partial effect of one standard deviation increase in the financial constraints measured using the KZ index, the WW index, and the HP index are all very small (-0.006, -0.115 and -0.003 respectively). Thus, a slight increase in the index will reduce the average durability

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[15] Farre-Mensa and Ljungqvist (2016) show that firms classified as constrained by the KZ index are marginally younger, have less cash, and more tangible capital in their balance sheets compared to their unconstrained counterpart. On the contrary, firms classified as constrained by the WW index and the HP index are relatively younger, have more cash and less tangible capital in their balance sheets. My sample also demonstrates these contrasting features between the KZ index and the other two indices.

[16] The White-Huber sandwich estimator corrects standard errors allowing for observations to be independent across firms but not necessarily within firms.

of investment by a small percentage. Therefore, firms will invest in less durable assets only if they are extremely financially constrained (have a very high value of the KZ, the WW, or the HP index). The results also indicate that firms facing less financial constraints invest in more durable assets. This finding supports the hypothesis 1, and also the theoretical prediction made in Rampini (2019).

Coefficient of $Q$ is positive and significant for all three regressions in panel A. Hence, firms with more investment opportunities choose to invest in more durable capital for further growth. Firm size is significantly and positively affecting a firm's choice of durability i.e., bigger firms invest in more durable assets.[17] The negative relationship between durability and leverage suggests that firms that use more debt to purchase their assets are likely to increase investment in less durable capital. As durable assets are expensive to purchase, highly levered firms invest in less durable capital to reduce the amount of debt. Finally, firms with higher cash flow and a higher return on assets (higher profitability) invest more in durable capital.

### 4.4.3 Robustness to endogeneity and outliers

The contemporaneous relationship between financial constraints index and choice of durability can cause concerns of simultaneity bias. A severely constrained firm finds it difficult to invest in more durable assets. Again, the lower collateral value of less durable assets can make it even more difficult for the firm to obtain external finance for those assets and increase the likelihood of a firm to be financially constrained. As a result, the financial constraints measure might become endogenous and correlated with the error term of the equation that determines durability. To address this, I instrument the financial constraints variables with their respective first lags for all the regressions presented in panel A of Table 9. Panel B of Table 9 provides the results of the 2SLS estimation of equation (10).

When the KZ index measures financial constraints, the original finding of a small but negative relationship between financial constraints index and asset durability continues to hold. On the contrary, if I use either the WW index or the HP index as a measure of financial constraints, the negative relationship no longer holds. The coefficient turns out to be positive, larger in magnitude, and statistically significant for both WW and HP indices. The coefficients of firm-specific controls are mostly similar to those returned from OLS

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[17] The coefficient associated with the firm size is negative in the second regression in which the WW index measures the financial constraints. This negative value is due to the strong correlation (0.98) present between the WW index and the firm size. Removing WW from the regression gives a coefficient of size as 0.029.

estimations. Hence, the results remain qualitatively unchanged if the financial constraints are measured using the KZ index. In contrast, OLS estimation of equation (10) returns biased estimates with the WW index or the HP index used as proxies of financial constraints.

Table 9: Durability and financial constraints

| | Panel A | | | Panel B | | |
|---|---|---|---|---|---|---|
| | OLS estimation | | | 2SLS estimation | | |
| Durability | 1 | 2 | 3 | 4 | 5 | 6 |
| KZ | -0.001*** | | | -0.003*** | | |
| | (-3.54) | | | (4.29) | | |
| WW | | -1.124*** | | | 2.68*** | |
| | | (-14.45) | | | (10.30) | |
| HP | | | -0.006 | | | 0.268*** |
| | | | (-0.33) | | | (11.69) |
| Q | 0.005* | 0.005** | 0.005* | 0.005* | 0.001 | 0.006** |
| | (1.99) | (5.55) | (1.75) | (1.69) | (0.39) | (2) |
| cash flow | 0.026*** | 0.021*** | 0.029*** | 0.022*** | 0.045*** | 0.028*** |
| | (6.66) | (5.55) | (7.57) | (5.13) | (9.07) | (7.20) |
| size | 0.029*** | -0.027*** | 0.029*** | 0.028*** | 0.165*** | 0.055*** |
| | (9.16) | (-5.58) | (8.70) | (8.77) | (11.53) | (12.66) |
| ROA | 0.184*** | 0.087*** | 0.182*** | 0.188*** | 0.419** | 0.206*** |
| | (6.81) | (3.22) | (6.77) | (6.90) | (11.02) | (7.48) |
| leverage | -0.014* | -0.005 | -0.017** | -0.007 | -0.074 *** | -.026*** |
| | (-1.74) | (0.66) | (-2.24) | (-.091) | (-6.80) | (-3.03) |
| constant | 0.763*** | 0.757*** | 0.746*** | 0.763*** | 0.756*** | 1.47*** |
| | (62.93) | (41.5) | (13.33) | (41.61) | (32.74) | (23.92) |
| No of observations | 26,878 | 26,943 | 26,943 | 26,828 | 24,268 | 26,943 |

This table reports the OLS-FE estimates of the coefficients returned for the regression in equation (5). Panel A consisting of columns 1, 2, and 3 reports OLS regression results for financial constraints measured by Kaplan and Zingales index, Whited and Wu index, and Hadlock and Pierce index respectively. Panel B consisting of columns 4, 5 and, 6 reports the results from 2SLS estimation of the baseline regression for the respective financial constraints indices. For 2SLS estimation each financial constraints index is instrumented by first lags of the respective financial constraints index. The data is winsorized using cut-offs of 1% and 99%. All regressions control for firm and year fixed effects. The White-Huber estimator is used to correct for heteroskedasticity and clustering. The t-statistics are reported in parenthesis. ***, ** and, * are used to indicate significance at 1%, 5%, and 10% level, respectively.

Despite contrasting results, the findings using the KZ index are reliable in this analysis. The construction of the KZ index includes cash holdings by a firm with a negative loading while the other two indices (the WW index and the HP index) do not. Thus, according to the KZ index, firms with more cash holdings are relatively unconstrained. As durability increases the down payment of an asset; therefore, in the presence of collateral constraints, firms must be able to afford the higher down payment given its financial health. Firms with more cash holding may find themselves in a better position to finance the down payment, which is appropriately captured by the KZ index.

I also change the winsorization thresholds to check how the findings vary with outlier treatment. I winsorize the data using 2% and 98% cut-offs to test the robustness of the results. The findings remain relatively robust to changes in the winsorization cut-offs. The negative relation between financial constraints and asset durability continues to hold only when the KZ index measures the financial constraints. Similarly, for WW and HP indices, the coefficients remain relatively robust at different winsorization cut-offs for both OLS estimation and 2SLS estimation of the baseline regression. These findings indicate that hypothesis 2 is valid for a sample of extremely constrained (unconstrained) firms when their financial status is measured using the KZ index.

Table 10: Outlier treatment: Durability and financial constraints

| Durability ($D$) | OLS estimation | 2SLS estimation |
|---|---|---|
| KZ | -0.001*** | -0.002*** |
| | (-3.87) | (-4.49) |
| WW | -0.868*** | 2.08*** |
| | (-14.33) | (10.97) |
| HP | -0.011 | 0.232*** |
| | (-0.79) | (11.67) |

This table reports the coefficients returned for OLS and instrumental variable estimation of the regression in equation (10). The data is winsorized using cut-offs of 2% and 98%. All regressions control for firm and year fixed effects. White-Hubar estimator is used to correct for heteroskedasticity and clustering. The t-statistics are reported in parenthesis. ***,**, and * are used to indicate significance at 1%, 5%, and 10% level respectively.

## 4.5 Durability of asset and composition of physical capital

The industry-level data on physical capital and implied depreciation rate demonstrate a positive correlation between the share of structures in physical capital and the durability of capital in the manufacturing industry. In this section, I examine if firms belonging to sectors that use a lot of structures show different investment behavior compared to those that have a relatively lower share of structures in physical assets. I match firm-level data of my sample with industry-level data from BEA according to NAICS codes. For firms belonging to sectors that use a lot of structures, the choice of durability is not affected by financial constraints. On the contrary, firms that belong to sectors having a relatively lower share of structure invest in less durable capital as they become more financially constrained. The following table reports the estimated regression coefficients associated with financial constraints from equation (10) for high and low structure share firms. I only report results using the KZ index as a measure of financial constraints.

Table 11: Durability of asset and composition of physical capital

| Durability | KZ index |
|---|---|
| High structure share firms | 0.0005<br>(0.52) |
| No of observations | 5,854 |
| Low structure share firms | -0.002**<br>(-4.91) |
| No of observations | 17,538 |

This table reports the estimates of the coefficients returned for the KZ index of financial constraints from OLS estimation of the baseline model. Firm-level data in the sample is matched with the industry level data from BEA using NAICS codes at the 3-digit level. High (low) structure share firms are those firms that belong to sectors that have a share of structure above (below) the median in the manufacturing industry for the sample period. The data is winsorized using cut-offs of 1% and 99%. All regressions control for firm and year fixed effects. Heteroskedasticity and clustering correct standard errors are reported in the parenthesis. ** and * indicate statistical significance at 1% and 5% level of significance respectively.

The effect of financial constraints on durability choice is significant for firms having a relatively lower share of structures in physical capital at the sectoral level. On the other hand, the coefficient of financial constraints index is not significant for firms that have relatively higher share of structures. According to these findings, the effect of financial constraints on firm-level investment in durable assets also depends on the composition of physical capital at the sectoral level.

# Conclusion

In this paper, I explore the role of asset durability as a link between financial constraints and investment. Durability is an important feature of tangible assets, which has a dual effect on a firm's ability to obtain external financing. The higher resale value of durable assets increases their collateral value, which facilitates external financing. More durability, on the other hand, makes durable assets more expensive which increases the overall financing need of a firm, making it harder for a firm to finance the asset. Rampini (2019) proposes a theoretical model which shows that for financially constrained firms, the latter effect dominates over the first one and that durability can obstruct financing for these firms. Based on the theoretical propositions by Rampini (2019), I hypothesize that durability increases (does not affect) the external financing cost for constrained (unconstrained) firms and faced with higher financing need the constrained (unconstrained) firms choose to invest in less (more) durable assets.

I empirically test my hypotheses by using the depreciation rate as a measure of durability. In the first specification, I examine the effect of durability on investment-cash flow sensitivity, a widely used measure of financial constraints. The results show that an increase in asset durability increases investment-cash flow sensitivity for constrained firms. This finding indicates that durability increases the cost of external finance for firms that are financially constrained. On the contrary, for unconstrained firms, the effect of durability on the cost of external finance is ambiguous and largely depends on constraint selection. In an alternative specification, I use index-based measures of financial constraints to find that extremely constrained firms choose to invest in relatively less durable capital compared to relatively unconstrained firms. At the industry level, this effect of financial constraints on durability choice is more prominent for firms that belong to sectors with a relatively lower share of structures in physical capital.

One limitation of my paper is, the sample consists only of listed firms that are not entirely financially constrained. These firms can often turn to equity financing whenever debt financing is unavailable. Hence, the findings give a general idea of how financial constraints can affect firm investment through asset durability. Additionally, some of the findings of this paper show sensitivity to certain robustness checks. The overall findings thereby generate mixed support towards the theoretical link between durability and firm financing established in Rampini (2019). The implications of the findings suggest that increased durability of assets may not necessarily alleviate the financial constraints of firms that are extremely constrained. Thus, in the event of an economic downturn, firms that are struggling with financing their assets can choose to invest in less durable assets and increase investment in more durable assets as their financial situation improves.

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# Appendix

## Variable definitions:

$$\textit{Investment}\,(I) = \frac{\textit{capital expenditures}\,(capx)}{\textit{lagged net property, plant and equipment}\,(ppent)}$$

$$Q = \frac{\textit{total assets}\,(at) + [\textit{closing price}\,(prcc_f) \times \textit{common shares outstanding}\,(csho)] - \textit{common equity}\,(ceq) - \textit{deffrerd taxes}\,(txdb)}{\textit{total asset}\,(at)}$$

$$\textit{cash flow}\,(cf) = \frac{\textit{income before extraordinary items}\,(ib) + \textit{depreciation and amortization}\,(dp)}{\textit{lagged net property, plant and equipment}\,(ppent)}$$

$$\textit{Return on assets}\,(ROA) = \frac{\textit{operating income before depreciation}\,(oibdp)}{\textit{total assets}\,(at)}$$

$$\textit{leverage} = \frac{\textit{total long term debt}\,(dltt) + \textit{debt in current liabilities}\,(dlc)}{\textit{total long term debt}\,(dltt) + \textit{debt in current liabilities}\,(dlc) + \textit{stockholders equity}\,(seq)}$$

Table A1: **Sample construction**

| Original sample | 120,344 |
|---|---:|
| Elimination criteria | Loss of observations |
| Total asset(AT),physical asset (PPEGT) or sale (SALE) is zero or negative | 5,801 |
| Capital stock (PPENT) less than $5million | 37,563 |
| Cash (CHE) is zero | 620 |
| Real asset growth rate bigger than 100% | 14,409 |
| Real sales growth rate bigger than 100% | 6,925 |
| Q negative or greater than 10 | 5,123 |
| Mean depreciation zero, negative or greater than 1 | 5,629 |
| Missing capital stock | 5,818 |
| Firms entering for at least 3 or more consecutive years | 512 |
| Final sample | 37,944 |

Table A2: Estimated Physical Capital Depreciation Rate

| **Industry** | **Mean** $\delta_{it}$ |
|---|---|
| Food | 0.071 |
| Oil | 0.096 |
| Textile | 0.099 |
| Durables | 0.096 |
| Chemicals | 0.080 |
| Consumption goods | 0.069 |
| Construction | 0.100 |
| Steel | 0.064 |
| Fabricated products | 0.070 |
| Machinery | 0.085 |
| Auto mobile | 0.075 |
| Transportation | 0.082 |
| Retail | 0.084 |
| Other | 0.098 |

The table reports the mean of imputed depreciation rate by industry. Firms are sorted according to the 17-industry classification following Fama and French (1997). The sample includes 6,323 U.S firms for the sample period between 1983-2017.

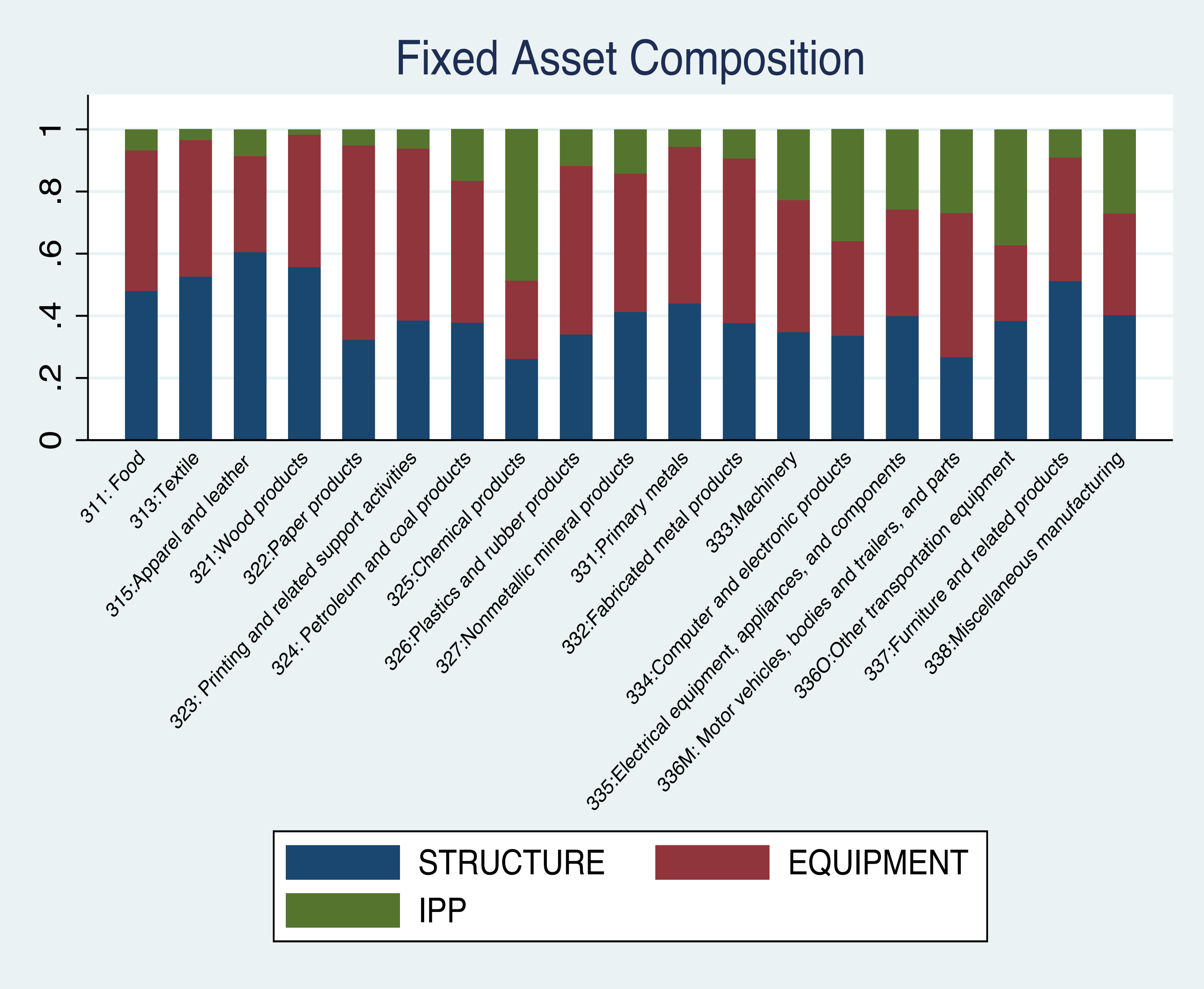

Figure 1: Composition of fixed assets for manufacturing industry

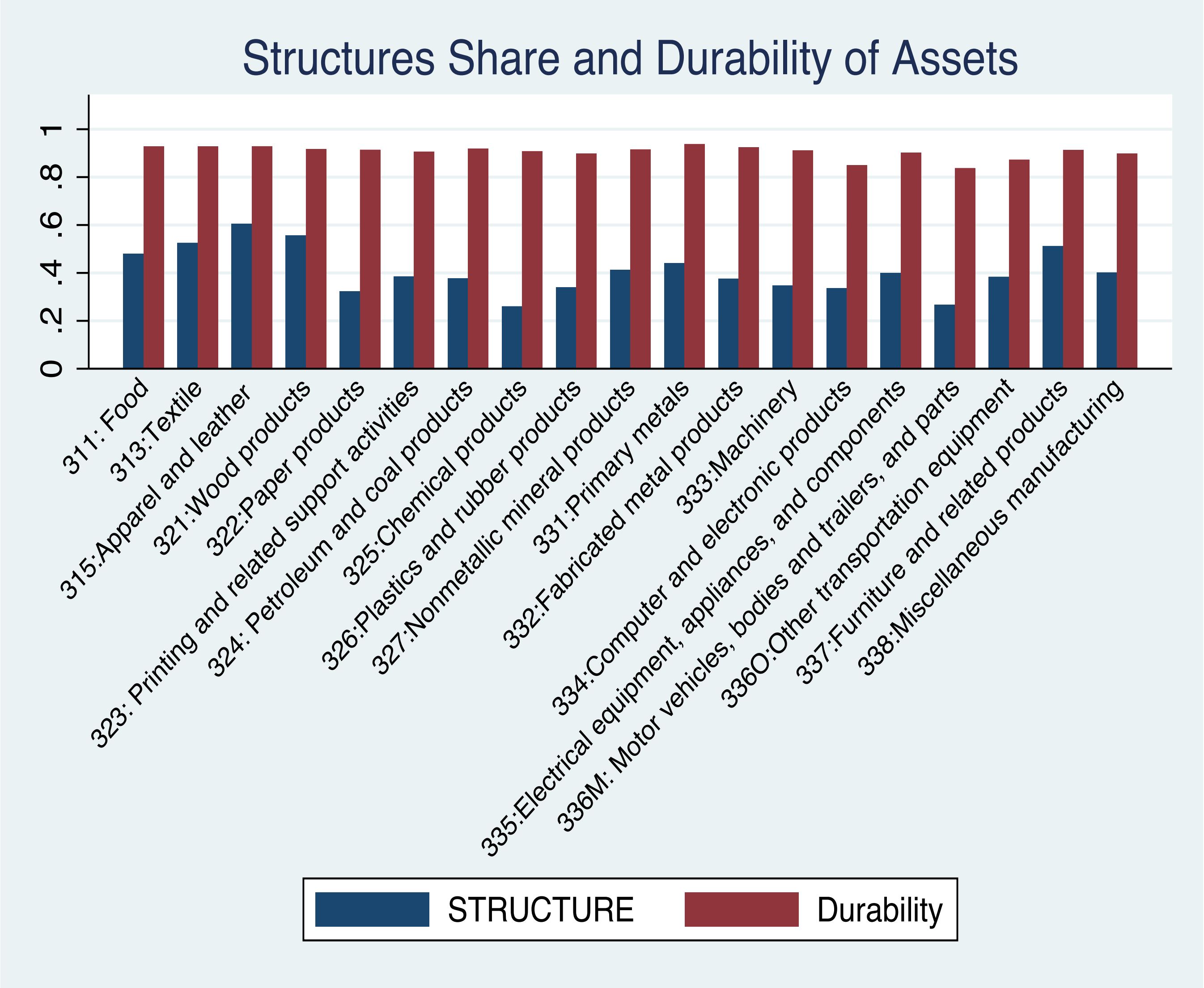

Figure 2: Durability and share of structure in fixed asset for manufacturing industry

Figure 3: Depreciation Rate of Manufacturing Industry