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The Asset Durability Premium

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Keywords: durability, financial constraints, collateral, cross-section of stock returns
JEL Classification: E2, E3, G12

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1 Introduction

We emphasize that durable capital is harder to finance not only for its greater down payment, but also for its larger price risk sensitivities to financial frictions. Our paper examines a novel risk premium channel that naturally emerges in general equilibrium, which finds that the price of durable capital is more procyclical, and therefore more durable capital is riskier than less durable capital. Our paper demonstrates that this general equilibrium price effect has critically important asset pricing implications for understanding firms' equity risk due to asset durability. As holding less durable capital provides hedging insurance against aggregate risk, our paper helps rationalize the asset durability premium that we document in the cross-section of stock returns using a quantitative general equilibrium model. The asset durability is an essential feature of capital and varies significantly across asset types. Our paper sheds light on a series of important issues by providing general insights for asset pricing, corporate finance, and the efficiency of capital reallocation involving firms' capital choices over new vs. used capital, light vs. heavy capital, and leasing vs. capital expenditure.[1]

Within a tractable model framework featuring risk-neutral firms in a stationary and partial equilibrium, Rampini (2019) derives an additional role for financial frictions as they trigger compositional changes in firms' balance sheets, concerning firms' endogenous choices over different types of capital characterized by asset durability. The canonical macro-finance model incorporating financial frictions in the production sector predicts that economic downturns exacerbate firms' financial constraints, which become more binding during bad times, significantly weakening firms' balance sheets (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997). We combine these two mechanisms and explicitly examine the general equilibrium effect of the financing channel of durable capital Rampini (2019) and its asset pricing implications for understanding equity risk due to asset durability. In particular, we develop a fully-fledged quantitative general equilibrium model with aggregate uncertainty that allows firms grappling with tightened financial constraints during recessions to dynamically adjust the composition of durable and non-durable capital through financing. Our model shows that firms' substitutability over asset durability introduces an important but under-explored general equilibrium effect. A novel *risk-premium* channel naturally emerges in our model, whereby durable capital is harder to finance not only because it has a greater down payment, as in Rampini (2019), but also because it exhibits extra risk sensitivities to financial shocks relative to non-durable capital. More durable assets entail higher risk, while less durable assets serve as a hedge against aggregate risks, especially during recessions when financial constraints are tightened.

To begin our analysis, we first construct empirical proxies for firm-level asset durability and examine the cross-sectional variation in the relationship between stock returns and asset durability.

[1] See the seminal papers of Eisfeldt and Rampini (2006, 2007, 2009) along with a long list such as Gavazza, Lizzeri, and Roketskiy (2014), Lanteri (2018), Rampini (2019), Ai, Li, Li, and Schlag (2020a), Gavazza and Lanteri (2021), Ma, Murfin, and Pratt (2022), and Lanteri and Rampini (2023).

Our paper documents a significant and positive durability spread (i.e., financially constrained firms with higher asset durability yield larger average returns than those with lower asset durability). We then show in a quantitative general equilibrium model that our highlighted risk-premium channel arises from firms' substitutability over asset durability driven by changes in the tightness of the financial constraints. Our model finds that firms substitute less durable capital for more durable capital with constrained borrowing, which results in larger drops in equilibrium prices of durable capital during recessions; as a result, holding durable capital is riskier. Hence, a firm holding a larger proportion of more durable assets commands a higher expected return. Finally, we provide additional empirical evidence for further model validation.

To study the empirical relationship between asset durability and expected stock returns, our paper contributes to the literature by providing the first empirical measure of asset durability at the firm level. This measure certainly will facilitate the development of additional empirical research highlighting the importance of studying asset durability in asset pricing and corporate finance theory. Specifically, the novelty of our measure lies in the aggregation of the differed durability across refined asset categories of a firm's portfolio, which is derived from the depreciation data in the U.S. Bureau of Economic Analysis (BEA) fixed asset table.[2] This table provides detailed estimates for depreciation rates and net capital stocks at fixed costs, covering a broad array of assets that include both physical assets (e.g., structures and equipment) and intangible assets. For each year, we construct the asset-level durability across assets listed in the BEA table, calculating in industry-level asset durability. We then obtain a firm-level measure of asset durability by calculating the value-weighted average of industry-level asset durability indices across the business segments in which the firm operates. Finally, we derive the firm-level asset durability measure.

Following Rampini (2019), we maintain that the financial constraint is critical for firms that seek to optimize the composition of durable and less durable capital. With our constructed firm-level asset durability measure, we document significant heterogeneities in asset durability across firms. Importantly, we show that firms' asset durability shifts toward less durable capital if they face greater financial constraints. Given that the financial constraint is an essential link for firms' asset durability decisions that affect firms' valuations, we further explore asset pricing implications by focusing on financially constrained firms. In particular, we construct five portfolios that are univariate-sorted based on firms' asset durability relative to their industry peers and then examine the return differences across different portfolios. Our results suggest that there is a statistically significant asset durability return spread among financially constrained firms. The levered return spread between the highest durability quintile portfolio and the lowest durability quintile portfolio averages approximately 3.56% to 6.93% per annum, depending on the specific measure that we use to sample financially constrained firms. Given that constrained firms with larger asset durability are more leveraged in the data, greater leverage ratio can generically bump up the leveraged returns

[2]Asset durability can be measured using different methods, such as modeling with geometric depreciation rates or finite service life, as demonstrated by Rampini (2019). Our approach calculates a firm's asset durability as the value-weighted average of the durability of various assets owned by the firm.

of a portfolio with increased asset durability. Nonetheless, our paper documents that the return spreads between the highest and the lowest durability quintile are still sizeable ranging from 2.34% to 4.75% even after controlling for the leverage effect. Hence, termed as the "Asset Durability Premium", this spread captures differences in average portfolio returns between the highest and lowest portfolios sorted by the asset durability measure, regardless of leverage ratio differences across portfolios. We show that implementing a high-minus-low strategy based on asset durability spread results in an annualized Sharpe ratio of 0.59 and 0.49 for levered and unlevered returns respectively, comparable to that of the market portfolio. In contrast, the durability spread is no longer pronounced if we condition our sample on non-constrained firms. Our empirical findings motivate our theoretical constructions featuring firms' choices over asset durability, which serves to rationalize the asset durability premium when the borrowing constraint is tightened.

We then develop a general equilibrium model with heterogeneous firms subject to occasionally binding borrowing constraints. Firms are ex-ante homogeneous but ex-post heterogeneous in productivity realizations, which then affect their net worth, investment, and hiring and debt positions. Importantly, firms pose capital as collateral to incur external debt financing (e.g., Kiyotaki and Moore (1997), Gertler and Kiyotaki (2010)), which reflects the presence of financial frictions by which lending contracts can not be fully enforced. Following Rampini (2019), our model distinguishes between durable and non-durable capital with respect to their geometric depreciation rates while both capital types are collateralizeable for financing. However, beyond the insights of the partial equilibrium studied in Rampini (2019), our model examines the dynamic trade-off between choosing durable and non-durable capital in general equilibrium under aggregate uncertainty. At the aggregate level, firms' profits are affected both by aggregate productivity shocks and financial shocks that unexpectedly liquidate firms' net worth before continuing to the next period. Our dynamic stochastic general equilibrium framework then demonstrates that firms' choices of asset durability over business cycles have critical asset pricing implications for cross-sectional stock returns. In addition, our model inherits the assumptions in Ai, Li, Li, and Schlag (2020a) that keep the cross-firm aggregation results tractable. However, without imposing an always binding borrowing constraint as in Ai, Li, Li, and Schlag (2020a) for a local model solution around the steady states, our quantitative model is solved globally and obtains a firm's decision rules that allow for occasionally binding constraints using an efficient parameterized expectation algorithm (Christiano and Fisher, 2000). Our model solution then gives us the exact flexibility to compare and contrast the price effects of firms' asset durability decisions with and without a binding constraint, which helps us isolate the importance of the risk-premium channel underexplored in the literature.

With our model, we first find that firms collectively become more financially constrained and substitute away from holding expensive and more durable capital in economic downturns that are triggered by adverse aggregate productivity and financial shocks. At the firm-level, firms with low net worth but high financing needs endogenously acquire less durable assets, and the heterogeneity in productivity and net worth translates into endogenous cross-firm heterogeneity with respect to asset durability. We show that this result partly follows Rampini (2019), since holding more durable capital incurs a lower frictionless user cost but is more costly for higher upfront down payments, which makes it hard to finance. What's also important is that our general equilibrium model highlights that durable capital is harder to finance not only for its greater down payment, but also for its larger price risk sensitivities to financial frictions, which turns out to be critically important for understanding the riskiness of firms' asset portfolios driven by asset durability. Our paper therefore contributes to the literature by delving into an underexplored risk-premium channel that appears naturally in the general equilibrium, by which capital prices adjust to reflect compositional changes on firms' balance sheets that deliver the asset durability premium.

Specifically, we show that when firms are more financially constrained, they shift asset holdings toward cheaper and less durable capital. The price of non-durable capital is therefore less procyclical and thus less risky compared to that of durable capital. Consequently, at the aggregate level, more durable capital commands higher expected returns in equilibrium. In the cross-section, firms with high asset durability earn higher risk premia. On the contrary, given our model's flexibility without imposing a binding constraint in equilibrium, we find that when firms are not financially constrained, the weakened substitutability between durable and less durable capital leads to very small changes in relative capital prices, which in turn results in small return spreads between durable and non-durable portfolios.

Quantitatively, we demonstrate that our model, once calibrated to match both standard U.S. business cycle moments and different depreciation rates of more durable and less durable capital goods in our data, generates the subsitutability between capital types and the relative cyclicality of capital prices. Our model finds that when firms are financially constrained, they hold 2.8% less on durable capital and invest 2.5% less through acquiring durable capital relative to non-durable capital on average. In addition, we find that the price of durable capital is about three to four times more volatile than that of non-durable capital over business cycles as measured by unconditional price volatility or by the covariance between capital prices and the stochastic discount factor. Through cross-sectional simulation, our model exhibits extra riskiness for firms' holding durable capital and generates a levered (unlevered) return spread between the highest durability quintile portfolio and the lowest durability quintile portfolio at 4.34% (1.32%) annually, which explains at least about 80% (30%) of observed spreads in our data. Importantly, another contribution of our paper is that our model can quantitatively differentiate the two offsetting channels that affect the firms' substitutability over asset durability and the cross-section of stock returns, including the the down payment channel as in Rampini (2019) that finds durable asset financing much riskier and the asset collateralizeability channel as in Ai, Li, Li, and Schlag (2020a) that financing non-durable capital is riskier for it shorts the collateralizeability value. Our calibrated model suggests that our newly documented risk premium channel delivers a quantitatively large general equilibrium price effect that increases the relative riskiness of more durable capital even after controlling for the asset collateralizeability channel. Our model implications are consistent with all the empirical facts regarding business cycles and the stock returns in the cross-section.

We then complete additional empirical tests in support of our model's assumptions and predictions, which provide further model validations. First, our model predicts that durable assets are more expensive than non-durable assets, not only due to higher down payments but also larger risk sensitivities and price volatilities driven by financial shocks. We present direct evidence illustrating the variance in price cyclicality, substantiating our model's prediction that the capital price of more durable assets displays greater sensitivity to macroeconomic shocks compared to less durable capital. We find that the price of durable assets is more responsive to aggregate financial shocks as measured by the size of default premium and the credit spread as in Gilchrist and Zakrajšek (2012) (GZ hereafter). Second, with respect to the substitutability between asset durabilities as we highlight in our model, we further show that the durability of financially constrained firms is low given adverse financial shock, suggesting a preference for cheaper, less durable assets when borrowing constraints are binding. Moreover, durability increases with the positive realization of the idiosyncratic productivity shock, indicating that firms accumulate net worth to acquire durable assets. Conversely, we find no evidence among financially unconstrained firms.

In addition, we consider a two-factor asset pricing model that includes aggregate stock market returns and financial shocks gauged by the default premium and the GZ credit spreads as the pricing factors. We then implement a generalized method of moments (GMM) estimation of Cochrane (2005) to test the price of macroeconomic risk and the exposure to such risk of asset-durability-sorted portfolios. Our two-factor model captures reasonably well the variation in the average returns of the asset-durability-sorted portfolios, and we find that the price of risk with respect to default premium and GZ credit spread is significantly negative, consistent with our model prediction. Moreover, GMM-implied alphas (i.e., pricing errors) in the high-minus-low spread portfolio sorted on asset durability are not statistically significant. Finally, the goodness of fit for our two-factor model is driven by the increasing negative exposure of the high-durability portfolios to financial shock. Taken together, high-asset-durability firms exhibit higher expected stock returns because they have negative betas on financial shocks that are negatively priced.

Finally, we explore several potential explanations from the literature for the cross-sectional variation in portfolio returns sorted by asset durability. Conducting asset pricing factor tests, we find that alphas remain significant even after we account for Fama and French (2015) five factors or Hou, Xue, and Zhang (2015) (HXZ hereafter) q-factors. This implies that the positive asset-durability-return relationship cannot be explained by established firm characteristics like size, value, profitability, and investment. Additionally, we employ monthly Fama and MacBeth (1973) regressions to assess the ability of firm-level durability to predict cross-sectional stock returns. This approach allows us to control for an extensive list of firm characteristics that typically predict stock returns. The slope coefficient associated with a firm's lagged durability is both economically and statistically significant. For instance, even after we control for firms' financial leverage, a one-standard-deviation increase in a firm's durability corresponds to a 2.13% increase in a firms' expected stock return. To ensure robustness, we confirm that the positive durability-return relation is not driven by other known predictors correlated with the durability measure. Specifically, we consider potential explanations from the literature, including collateralizability, operating leverage and adjustment costs, output durability, and financial distress.[3] Fama and MacBeth (1973) regressions suggest that the asset-durability-return relation persists even when we control for firm characteristics associated with these channels.

Related Literature. Our paper builds on the corporate finance literature that emphasizes the importance of collateral for firms' capital structure decisions. Albuquerque and Hopenhayn (2004) study dynamic financing with limited commitment. Rampini and Viswanathan (2010, 2013) develop a joint theory of capital structure and risk management based on firms' asset collateralizability. Schmid (2008) considers the quantitative implications of dynamic financing with collateral constraints. Nikolov, Schmid, and Steri (2021) meanwhile examine the quantitative implications of various sources of financial frictions on firms' financing decisions, including the collateral constraint. Falato, Kadyrzhanova, Sim, and Steri (2022) provide empirical evidence for the link between asset collateralizability and leverage in aggregate time series and in the cross-section. Our paper departs from these papers in that we explicitly study firms' optimal asset acquisition decisions among assets with different durabilities under the context of an occasionally binding collateral constraint, as in Rampini (2019). However, different from Rampini (2019), we bring an asset durability decision into a general equilibrium framework, take aggregate shocks into accounts, and highlight important asset pricing implications of an underexplored channel on equilibrium capital prices per firms' decision with respect to asset durability through the lens of cross-sectional stock returns.

A rich literature that starts with Eisfeldt and Rampini (2006) has examined how durable assets are reallocated among diverse producers. In this body of research, a consistent empirical observation is that financially constrained agents often engage in the acquisition of assets within secondary markets. Specifically, Eisfeldt and Rampini (2007) investigate investment decisions in new and used capital within the context of financial frictions, demonstrating that financially constrained firms tend to prefer older investment goods. Gavazza et al. (2014) explore welfare gains from secondary markets for durable goods, especially with respect to consumer heterogeneity. Lanteri (2018) examines the market for used investment goods using a quantitative business-cycle model that incorporates heterogeneous firms subject to idiosyncratic productivity shocks, and Rampini (2019) examines the effects of asset durability on investment financing in the presence of collateral constraints. Building upon these insights, Hu, Li, and Xu (2020) adjust firms' marginal product of capital (MPK) by considering leased capital, highlighting leasing as an additional channel for capital reallocation that alters patterns of capital misallocation. Gavazza and Lanteri (2021) em-

[3]Existing systematic risks that may explain the documented asset durability premium include collateralizability (e.g., Ai, Li, Li, and Schlag (2020a)), operating leverage and adjustment costs (e.g., Zhang (2005), Gu, Hackbarth, and Johnson (2018), and Kim and Kung (2017)), output durability (e.g., Gomes, Kogan, and Yogo (2009)), and financial distress (e.g., Griffin and Lemmon (2002), Bharath and Shumway (2008), and Campbell, Hilscher, and Szilagyi (2008)).

phasize the role of secondary markets in reallocating used consumer durable goods from wealthier to poorer households, proposing that this mechanism contributes to the transmission of credit shocks. Meanwhile, Ma et al. (2022) utilize a large dataset on equipment transactions and document a negative correlation between firm age and capital age. Lanteri and Rampini (2023) comprehensively evaluate the welfare cost of two types of pecuniary externalities involved in capital reallocation via the resale of old capital. Our paper extends the existing literature by further exploring asset pricing implications of firms' capital choices and capital reallocation among firms. In particular, we develop a quantitative general equilibrium model that features firms' endogenous choices over asset durabilities. Our paper focuses on a more general feature of asset durability, and our findings complement views that differentiate new from used capital. For example, two different but brand new models of machines could well have different degrees of asset durability. Brand new equipment may also have shorter asset durability than used equipment with high-end configuration.

Our study also builds on the large macroeconomics literature that studies the role of credit market frictions in generating fluctuations over business cycles (see Quadrini (2011) and Brunnermeier, Eisenbach, and Sannikov (2012) for extensive reviews). The papers most related to ours emphasize the importance of borrowing constraints and contract enforcements, such as Kiyotaki and Moore (1997, 2012), Gertler and Kiyotaki (2010), He and Krishnamurthy (2013), Brunnermeier and Sannikov (2014), and Elenev, Landvoigt, and Van Nieuwerburgh (2021). In addition, Gomes, Yamarthy, and Yaron (2015) study asset pricing implications of credit market frictions in a production economy. Our model examines the impacts of financial shocks on constraining firms' balance sheets occasionally over business cycles, which causes firms to optimally adjust their asset durability. We show that dynamic substitutabilities between durable and non-durable capital not only matter for the riskiness of capital prices in equilibrium, but also have great asset pricing implications for the cross-section of stock returns.

Our paper then contributes to the literature on production-based asset pricing, for which Kogan and Papanikolaou (2012) provide an excellent survey. From a methodological point of view, our general equilibrium model allows for a cross section of firms with heterogeneous productivity and is related to previous papers including Gomes, Kogan, and Zhang (2003), Gârleanu, Kogan, and Panageas (2012), Ai and Kiku (2013), and Kogan, Papanikolaou, and Stoffman (2017). Compared to these papers, we incorporate financial frictions in our model and study asset pricing implications of firms' occasionally binding collateral constraints. In this regard, our paper is closely related to Ai, Li, Li, and Schlag (2020a), which use a similar model framework and aggregation technique to study cross-sectional stock returns by focusing on the value of asset collateralizeability. They show that more collateralizable assets provide insurance against aggregate shocks by relaxing collateral constraints, especially in recessions when financial constraints become more binding. As highlighted in Rampini (2019), such a collateralizeability channel serves as a distinct channel by which firms' choices between durable and less durable capital may be further affected in addition to the trade-off of down payments. Our paper differs from Ai, Li, Li, and Schlag (2020a) in two important dimensions. First, our model nests both channels of the down-payment trade-offs and the collateralizeability effects as more durable assets are more collateralizeable. Our model features the novelty that a risk-premium channel emerges in general equilibrium that makes durable capital riskier in addition to its larger down payment compared to less durable capital even controlling for the asset collateralizeability value differences. Second, rather than imposing an always binding constraint, our model is solved globally in which firms' capital financing are allowed to be constrained occasionally. This enables us to compare and contrast the model scenarios with and without the binding constraints. At the same time, our model delivers the extra price risk sensitivities of durable capital prices over business cycles.

Our paper is also connected to a broader literature linking investment to the cross-section of expected returns. Zhang (2005) provides an investment-based explanation for the value premium. Li (2011) and Lin (2012) focus on the relationship between R&D investment and expected stock returns. Eisfeldt and Papanikolaou (2013) develop a model of organizational capital and expected returns. Also, Belo, Lin, and Yang (2018) meanwhile study implications of equity financing frictions on the cross-section of stock returns. Tuzel (2010) documents a positive relationship between firms' real estate holding and expected returns and proposes an adjustment cost explanation. While non-residual real estate may be considered one particular type of durable capital, our paper presents a different channel to rationalize asset pricing facts, given firms' choices over asset durability under financial constraints.

The rest of our paper is organized as follows. We summarize our empirical results on the relationship between asset durability and expected returns in Section 2. We introduce a general equilibrium model with occasionally binding collateral constraints in Section 3, and analyze asset pricing implications in Section 4. In Section 5, we provide a quantitative analysis of our model and discuss our model results. In Section 6, we provide additional supporting evidence for our model, and then conclude our paper with Section 7. Details on data construction are delegated to Section IV of the Internet Appendix. In Section V of the Internet Appendix, we provide details on our model solution algorithm and present additional empirical evidence to establish the robustness of our results.

2 Empirical Facts

This section presents cross-sectional and aggregate evidence that underscores the significance of asset durability as a critical link of the cross-section of stock returns, particularly for financially constrained firms.

2.1 Measuring Asset Durability

To empirically investigate the connection between asset durability and expected returns, as well as to test our theoretical predictions, we must develop distinct measures of asset durability concerning a wide range of assets, including physical assets (e.g., equipment and structures) and intangible assets. We measure an asset's durability based on its service life, calculated as the reciprocal of the asset's depreciation rate.

We construct the measure of asset durability from the Bureau of Economic Analysis (BEA) fixed asset table, which provides detailed estimates for implied depreciation rates and net capital stocks at a fixed cost."[4] This table dissects depreciation rates across different assets that span industries and include virtually all economic sectors within the United States.[5][6]

Constructing Industry- and Firm-level Asset Durability Measures

As the BEA table provides implied rates of depreciation, we calculate the durability of tangible assets k utilized by industry j in year t as the service life of asset k (i.e., the reciprocal of its depreciation rate). We value-weight the asset-level durability across assets in the BEA table to formulate an industry-level asset durability index using the following equation:

$$\text{Asset Durability}_{j,t} = \sum_{k} \bar{w}_{k,j,t} \times \text{Asset Durability Score}_{k,j,t}, \tag{1}$$

in which Asset Durability$_{j,t}$ represents the asset durability for industry j in year t, and $\bar{w}_{k,j,t}$ denotes the proportion of industry j's capital stocks attributed to asset h divided by total capital stocks in year t from the BEA table. Additionally, Asset Durability Score$_{k,j,t}$ represents the durability score of asset k employed by industry j in year t. The resulting asset durability index offers a relative ranking of asset durability, reflecting the composition of tangible assets within each industry.

Meanwhile, for intellectual property and product, we compute its asset durability as the reciprocal of industry j's depreciation rate in year t.[7]

Furthermore, we create a firm-level metric for asset durability that includes both tangible and intangible assets. This metric is computed as the value-weighted average of industry-level asset durability indices across the various business segments within which the firm operates

$$\text{Asset Durability}_{i,t} \quad = \quad \sum_{j=1}^{n_{i,t}} \widetilde{w}_{i,j,t} \times \text{Asset Durability}_{j,t}, \tag{2}$$

in which Asset Durability$_{i,t}$ represents the asset durability of firm i at time t. The variable $n_{i,t}$

[4] Our data originate from the Bureau of Economic Analysis (BEA) fixed asset table, which furnishes non-residential detailed estimates for implied depreciation rates and net capital stocks at a fixed cost. This table breaks down implied depreciation rates and net capital stocks across various asset categories, encompassing a wide array of industries.

[5] Due to data limitations, we exclude detailed assets related to intellectual property and products. As a result, we analyze intellectual property and product depreciation rates at the industry level. Land is not encompassed within the BEA's non-residential asset categories, and we assume it has infinite durability across all industries.

[6] The BEA employs the 1997 North American Industry Classification System (NAICS) for industry classification. Hence, we align the 63 BEA industries with Compustat firms using NAICS codes.

[7] In this paper, the terms 'intellectual property and product' and 'intangible' are used interchangeably.

denotes the number of industry segments that the firm operates in during year t, and $\widetilde{w}_{i,j,t}$ represents the proportion of firm i's sales attributed to industry segment j relative to total sales in year t. Additionally, Asset Durability$_{j,t}$ denotes the asset durability of industry segment j in year t, as calculated using equation (1).

We then obtain firm i's asset durability by considering both physical assets, as well as for intellectual property and product. To do so, we weight these two types of asset durability by their respective capital stocks: tangible capital PPEGT$_{i,t}$ and intangible capital INTAN$_{i,t}$ for firm i in year t.[8]

In our primary empirical analysis, we utilize this firm-level metric, which is expected to offer a more nuanced level of variation in asset durability across firms compared to their industry-level counterpart.[9] Leveraging the availability of the asset durability measure in conjunction with U.S. data on publicly traded companies, we use a period spanning from 1978 to 2016 for our analysis.

2.2 Asset Durability and Financial Constraints

In line with Rampini (2019), our paper highlights that financial constraints strongly impact firms' decisions regarding the mix of durable and less durable capital. Utilizing the firm-level asset durability measure, we present our initial evidence that connects financial constraints and asset durability. This finding provides empirical support for both Rampini (2019) and our own theoretical prediction.

In this subsection, we explore the relationship between a firm's financial constraints and asset durability. We utilize four alternative metrics to gauge the extent of a firm's financial constraints: the dividend payment dummy (Farre-Mensa and Ljungqvist (2016), referred to as DIV), the Size-Age index (Hadlock and Pierce (2010), referred to as SA index), the credit rating (Farre-Mensa and Ljungqvist (2016), referred to as Rating), and the Whited-Wu index (Whited and Wu (2006), Hennessy and Whited (2007), referred to as WW index). Empirical analyses indicate a negative correlation between financial constraints (measured by non-dividend payment status, the SA index, and the WW index) and asset durability.[10] This suggests that firms under greater financial constraints tend to have less durable assets. Furthermore, we posit a positive link between a firm's profitability and its asset durability, as higher profitability can increase internal net worth, which potentially leads to investments in more durable assets. To verify these empirical predictions, we conduct the following analyses.

[Place Table 1 about here]

[8]For detailed information on the measurement of intangibles, please refer to Ai, Li, Li, and Schlag (2020a).

[9]Our asset durability measure remains robust even when constructed using depreciation expenditure data from Compustat.

[10]In contrast to the dividend payment dummy (DIV), the non-dividend payment dummy (Non-Div) denotes whether a firm does not pay dividends.

Our selection of financial variables is informed by both empirical predictions of our model and the literature. This leads us to anticipate negative coefficients for the non-dividend payment dummy, SA index, and WW index, while we expect a positive coefficient for profitability. In later sections of our model, we demonstrate that financially constrained firms, due to their reliance on internal funds, are inclined to choose "cheaper" and less durable assets. This pattern aligns with the expected negative correlation between a firm's financial constraints and its optimal decision for high-durability assets.

Specifications 1-4 in Table 1 present our outcomes for our univariate regressions, each focusing on either financial constraints or profitability. Meanwhile, specifications 5-7 present the results of our multivariate regressions, which account for other fundamental factors. The non-dividend dummy exhibits a significant and negative relationship with asset durability in both the univariate and multivariate specifications. This suggests that payout policy serves as a direct gauge of the value attributed to internal funds. Notably, the negative association with asset durability remains robust even when substituting the non-dividend payment dummy with alternative financial constraint measures. Other financial constraint indicators, such as the SA and WW indices, also exhibit significantly negative relationships with asset durability. Collectively, our outcomes in Table 1 drive our focus towards financially constrained firms, prompting us further explore asset pricing implications in subsequent sections.

2.3 Asset Durability and Leverage

In Table 2, we generate the firm-level durability measure and present summary statistics for asset durability and book leverage across both financially constrained and unconstrained firms in Compustat.

[Place Table 2 about here]

Panel A provides statistics for the financially constrained firm group compared to its unconstrained counterpart. Our primary empirical analysis focuses on the measure of financial constraint that uses the dividend payment dummy (Farre-Mensa and Ljungqvist (2016)), referred to as DIV.[11] Two key observations emerge from Panel A. First, the average asset durability among financially constrained firms is much lower at 12.66 compared to that of unconstrained firms at 16.54. This implies that financially constrained firms utilize capital with higher durability (lower depreciation rate). Second, the average book leverage of constrained firms is 0.24, which is lower than the average of their unconstrained counterparts at 0.33. This observation implies that financially constrained firms experience more pronounced external financing frictions and consequently borrow less as a result.

[11] We conducted tests using alternative financial constraint measures, including the SA index, credit rating, and the WW index. These four proxies yielded consistent empirical results.

In Panel B, we further sort financially constrained firms within Compustat into five quintiles based on their asset durability relative to peers with the same NAICS 3-digit industry classifications. We then provide an overview of firm characteristics across these quintiles. Notably, we observe significant variability in average asset durability (depreciation), ranging from 7.69 (0.19) in the lowest quintile (Quintile L) to an impressive 18.00 (0.11) in the highest quintile (Quintile H). Furthermore, the book leverage exhibits an upward trend as we move from the lowest to the highest asset durability quintile. Drawing from insights offered in Table 2, we observe a discernible correlation between asset durability and external financing activities within the constrained group. Moreover, asset durability stands as a primary determinant of firms' capital structure in terms of liability. Next, we present evidence demonstrating that asset durability also significantly influences firms' asset side, as evidenced by equity returns that display heterogeneous asset durability across firms.

2.4 Asset Durability and Expected Returns

Once again, we keep focusing on the set of financially constrained firms. A firm is categorized as financially constrained if its dividend payment is zero, if its credit rating is unavailable, or if its WW (SA) index exceeds the median value for a specific year.

To explore the connection between asset durability and future stock returns across different firms, we create five portfolios based on a firm's current asset durability and present the average stock returns of these portfolios after their formation. The measurement of durability is conducted annually, following the method outlined in Section 2.1. To minimize investment strategy transaction costs, we concentrate on annual rebalancing rather than monthly rebalancing.

At the end of June in each year from 1978 to 2017, we rank firms according to their asset durability relative to their peers within the corresponding NAICS 3-digit industries. This classification generates industry-specific breaking points for quintile portfolios for each June. Subsequently, we allocate firms with positive asset durability in year $t-1$ to these portfolios. Consequently, the low (high) portfolio encompasses firms with the lowest (highest) asset durability within each industry. In order to scrutinize the relationship between asset durability and returns, we establish a high-minus-low portfolio, which involves adopting a long position in the high durability portfolio and a short position in the low asset durability portfolio.

After we establish the six portfolios (ranging from low to high and high-minus-low), we calculate the value-weighted monthly returns of these portfolios across the next twelve months (from July in year t to June in year $t+1$). We report both levered and unlevered returns to disentangle the leverage effect from our primary mechanism, "price cyclicality."[12] To determine the average excess

[12] The unlevered return of a firm is defined as its levered return in the dataset multiplied by one minus its leverage ratio, as established in the theoretical context outlined in equation (45) in Section 4.3. Table 1 provides evidence of a negative association between asset durability and financial constraints. Firms with lower financial constraints can acquire more durable assets by issuing additional debt and assuming higher leverage. Consequently, firms with higher asset durability experience elevated expected returns, primarily

stock return at the portfolio level for each period, we assign a weight to each firm in the portfolio based on its market capitalization size at the time of portfolio creation. This weighting mechanism allocates relatively more weight to larger firms within the economy, thereby mitigating the potential impact of very small firms (which might be challenging to trade) on outcomes. Additionally, we eliminate firms with asset values or sales lower than 1 million from our sample, so we may further minimize the influence of small firms on our findings.

[Place Table 3 about here]

In Table 3, we report levered returns in the left panel and unlevered returns in the right panel. Panel A focuses on portfolio sorting of stocks of financially constrained firms while Panel B presents results for the whole firm sample. Each section of the table presents *annualized* average excess stock returns (E[R]-R_f, above the risk-free rate), t-statistics, standard deviations, and Sharpe ratios for different portfolios sorted on asset durability. This table presents compelling evidence that average excess returns increase with rising asset durability. We demonstrate that return differences, driven by asset durability, are pronounced exclusively among financially constrained firms, even after controlling for leverage differences across portfolios.

In the first panel of Panel A, the annualized average excess return for firms with high asset durability (Portfolio H) exceeds that of firms with low asset durability (Portfolio L) for both levered and unlevered returns. This divergence in returns is both economically substantial and statistically meaningful. In particular, the positive correlation between asset durability and levered stock returns holds true and is statistically significant for the long-short portfolio. Specifically, the high-minus-low portfolio exhibits a statistically significant average excess return of 6.93% (t-value of 2.86) and a Sharpe ratio of 0.59 when the status of financial constraints is indicated by the dividend payment dummy (DIV). This premium remains robust across alternative measures of financial constraint, as demonstrated in the second to fourth table sections. The return differential observed in the long-short high-minus-low (Portfolio H-L) strategy is therefore termed the "Asset Durability Premium." In addition, despite a less steep pattern, the unlevered returns in the right panel present a similarly upward-sloping pattern across different financial constraint measures. Moreover, the unlevered returns of long-short portfolio remain statistically significant though the magnitudes are somewhat smaller reflecting the leverage effects. Turing our attention to Panel B for portfolios of all firms regardless of the presence of financial constraints, we note a similar but rather trivial pattern of increasing average excess returns with asset durability. Both the levered and unlevered returns for the long-short portfolio are quite small and lack statistical significance.

Overall, Table 3 provides empirical evidence that firm-level asset durability helps predict future stock returns, especially among financially constrained firms. In the next section, we construct

driven by their greater leverage. Sections 4.3 and 5.5 will further disentangle the various mechanisms influencing the risk premium, both analytically and numerically, thereby demonstrating the pivotal roles played by the price cyclicality mechanism and the leverage effect.

a general equilibrium model featuring heterogeneous firms and financial constraints, so we may precisely formulate this notion and quantitatively account for the positive asset durability premium.

3 A General Equilibrium Model

In this section, we describe the model we use for rationalizing the asset durability spread. The aggregate aspect of the model is intended to follow standard macro models with collateral constraints such as in Kiyotaki and Moore (1997) and Gertler and Kiyotaki (2010). Our model further allows for idiosyncratic productivity shocks as well as firms' entry and exit margin, which results in the heterogeneous durability of assets in the cross-section as in Rampini (2019). These features allow us to generate quantitatively plausible firm dynamics and study the implications of asset durability for the cross-section of equity returns.

3.1 Households

Time is infinite and discrete. The representative household consists of a continuum of workers and a continuum of entrepreneurs. Workers (entrepreneurs) receive their labor (capital) incomes every period and submit them to the planner of the household, who makes decisions for consumption for all members of the household. Entrepreneurs and workers make their financial decisions separately.[13]

The household ranks the utility of consumption plans according to the following recursive preference as in Epstein and Zin (1989):

$$U_t = \left\{ (1-\beta) C_t^{1-\frac{1}{\psi}} + \beta \left(E_t [U_{t+1}^{1-\gamma}] \right)^{\frac{1-\frac{1}{\psi}}{1-\gamma}} \right\}^{\frac{1}{1-\frac{1}{\psi}}},$$

in which β is the time discount rate, ψ is the intertemporal elasticity of substitution, and γ denotes the degree of the relative risk aversion. As we show later in this paper, together with the endogenous growth and long-run risk, the recursive preference in our model generates a volatile pricing kernel and a sizable equity premium as in Bansal and Yaron (2004).

In every period t, the household consumes C_t and purchases $B_{i,t}$ of risk-free bonds from entrepreneur i, from which she will receive $B_{i,t}R_{f,t+1}$ in the next period, in which $R_{f,t+1}$ denotes the risk-free interest rate from period t to $t+1$. In addition, the household receives capital income $\Pi_{i,t}$ from entrepreneur i. We assume that the labor market is frictionless, and therefore the labor income from worker members is $W_t L_t$. The household budget constraint at time t can therefore be written as:

[13]Following Gertler and Kiyotaki (2010), we assume that household members make joint decisions on their consumption to avoid keeping the distribution of entrepreneur income as an extra state variable.

$$C_t + \int B_{i,t} di = W_t L_t + R_{f,t} \int B_{i,t-1} di + \int \Pi_{i,t} di.$$

We let M_{t+1} denote the stochastic discount factor of period t as implied by household optimization. With recursive preference, the stochastic discount factor is denoted as:

$$M_{t+1} = \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\frac{1}{\psi}} \left(\frac{U_{t+1}}{E_t[U_{t+1}^{1-\gamma}]^{\frac{1}{1-\gamma}}} \right)^{\frac{1}{\psi}-\gamma},$$

and the optimality of the intertemporal saving decisions implies that the risk-free interest rate must satisfy

$$E_t[M_{t+1}] R_{f,t+1} = 1.$$

3.2 Entrepreneurs

There is a continuum of entrepreneurs in our economy indexed by $i \in [0,1]$. Entrepreneurs are agents who pursue productive ideas. An entrepreneur who starts at time 0 draws an idea with initial productivity $\bar{z}_0$ and start to operate with an initial net worth N_0. Under our convention, N_0 is also the total net worth of all entrepreneurs at time 0 as the total measure of all entrepreneurs is normalized to one.

We let $N_{i,t}$ denote entrepreneur i's net worth at time t, and let $B_{i,t}$ denote the total amount of risk-free bond the entrepreneur issues to the household at time t. Thus, the time-t budget constraint for the entrepreneur is given as:

$$q_{d,t} K_{i,t+1}^{d} + q_{nd,t} K_{i,t+1}^{nd} = N_{i,t} + B_{i,t}. \tag{3}$$

In equation (3), we assume that two types of capital, type-d and type-nd, differ in their asset durability; that is, the former capital is more durable, while the latter capital is less durable. For brevity's sake, we denote these two types of capital with a superscript d for durable and nd for non-durable, respectively. These two types of capital depreciate at geometric depreciation rates $\delta_d < \delta_{nd}$ each period, with $\delta_h \in (0,1)$, for $h \in \{d, nd\}$. We use $q_{d,t}$ and $q_{nd,t}$ to denote their prices at time t, respectively. $K_{i,t+1}^{d}$ and $K_{i,t+1}^{nd}$ are the amount of capital that entrepreneur i purchases at time t, which can be used for production over the period from t to $t+1$. We assume that the entrepreneur only has access to risk-free borrowing contracts (i.e., we do not allow for state-contingent debt). At time t, the entrepreneur is assumed to have an opportunity to default on his contract and abscond with $1-\theta$ of both types of capital. Because lenders can retrieve a θ fraction of the type-h capital upon default, we assume entrepreneur's borrowing is subject to an occasionally binding constraint such that:

$$B_{i,t} \leq \theta \sum_{h \in \{d,nd\}} (1-\delta_h)\, q_{h,t} K_{i,t+1}^{h} \tag{4}$$

Following Rampini (2019), we assume that asset durability could well affect the degree of collateralizability. Specifically, the effective degree of collateralizability for a given type of capital, $\frac{B_{i,t}}{q_{h,t}K^h_{i,t+1}}$, when the borrowing constraint is binding is given by $\theta\left(1-\delta_h\right)$. This implies that more durable capital (i.e. lower δ_h) is more collateralizable. In our paper, we highlight that a clear distinction exists between the durability and collateralizability of an asset. According to Ai, Li, Li, and Schlag (2020a), an asset with higher colllateralizability lowers the riskiness of assets as insurance against aggregate shocks by relaxing the financing constraint. However, unlike that of the asset collateralizability, we show that asset durability, which is the key focus of our paper, affects not only the duration of assets but also the price of underlying assets. We show that the net effect of asset durability against the collateralizability of an asset means that the price of more durable assets exhibits greater risk sensitivities to aggregate shocks. In equilibrium, assets with longer durability embody higher riskiness than those with shorter durability.

From time t to $t+1$, the productivity of entrepreneur i evolves according to the law of motion:

$$z_{i,t+1} = z_{i,t}e^{\varepsilon_{i,t+1}}, \tag{5}$$

in which $\varepsilon_{i,t+1}$ is a Gaussian shock with mean μ_ε and variance σ^2_ε, assumed to be i.i.d. across agents i and over time. We use $\Pi\left(\bar{A}_{t+1}, z_{i,t+1}, K^d_{i,t+1}, K^{nd}_{i,t+1}\right)$ to denote entrepreneur i's equilibrium profit at time $t+1$ that arises from running a firm for production, in which $\bar{A}_{t+1}$ is aggregate productivity in period $t+1$, and $z_{i,t+1}$ denotes entrepreneur i's idiosyncratic productivity.[14] We provide the specification of the aggregate productivity processes later in Section 5.1.

In period $t+1$, after production, the entrepreneur experiences a financial shock with probability λ_{t+1}, upon which that entrepreneur loses his idea and must liquidate all his net worth $N_{i,t+1}$ and thus cannot continue to the next period.[15] Specifically, if such a liquidation shock hits, then the entrepreneur restarts with a new idea with initial productivity $\bar{z}_{t+1}$ and an initial net worth χS_{t+1}, as a fraction $\chi \in (0,1)$ of the total asset of the economy in period $t+1$, S_{t+1}. The total asset value of the economy is then given by:

$$S_{t+1} = \Pi\left(\bar{A}_{t+1}, K^d_{t+1}, K^{nd}_{t+1}\right) + \left(1-\delta_d\right)q_{d,t+1}K^d_{t+1} + \left(1-\delta_{nd}\right)q_{nd,t+1}K^{nd}_{t+1} \tag{6}$$

in which $\Pi\left(\bar{A}_{t+1}, K^d_{t+1}, K^{nd}_{t+1}\right)$ denotes the aggregate profit of all entrepreneurs then run firm productions as of period $t+1$.

Conditional on no liquidation shock realized in period $t+1$, the net worth $N_{i,t+1}$ of entrepreneur

[14]Therefore, we use firm and entrepreneur interchangeably depending on the context.

[15]This assumption effectively makes entrepreneurs less patient than the household and prevents them from saving their way out of the financial constraint.

i at time $t+1$ is determined as:

$$\begin{aligned} N_{i,t+1} &= \Pi\left(\bar{A}_{t+1}, z_{i,t+1}, K^d_{i,t+1}, K^{nd}_{i,t+1}\right) + (1-\delta_d)\, q_{d,t+1} K^d_{i,t+1} \\ &+ (1-\delta_{nd})\, q_{nd,t+1} K^{nd}_{i,t+1} - R_{f,t+1} B_{i,t}. \end{aligned} \tag{7}$$

The entrepreneur's net worth is the sum of profit that it receives from firm production and the non-depreciated capital of two types accounting for different depreciation rates δ_h after he pays back the debt borrowed from the last period plus interest. The aggregate net worth through integration over all entrepreneurs therefore satisfies:

$$N_{t+1} = (1-\lambda_{t+1})(S_{t+1} - R_{f,t+1} B_t) + \lambda_{t+1} \chi S_{t+1} \tag{8}$$

Whenever a liquidity shock hits, entrepreneurs submit their net worth to the household who choose consumption collectively for all members, and entrepreneurs then value their net worth using the same pricing kernel as the household. We let V^i_t denote the value function of entrepreneur i. It must satisfy the following Bellman equation:

$$V^i_t = \max_{\{K^d_{i,t+1}, K^{nd}_{i,t+1}, N_{i,t+1}, B_{i,t}\}} E_t\left[M_{t+1}\{\lambda_{t+1} N_{i,t+1} + (1-\lambda_{t+1})\, V^i_{t+1}\}\right], \tag{9}$$

subject to the budget constraint in equation (3), the collateral constraint in equation (4), and the law of motion of $N_{i,t+1}$ given by equation (7).

3.3 Production

Final Output As $z_{i,t}$ denotes the idiosyncratic productivity for entrepreneur i running a firm production at time t, output $y_{i,t}$ of firm i at time t is assumed to be generated through the following production technology:

$$y_{i,t} = \bar{A}_t \left[z^{1-\nu}_{i,t} \left(K^d_{i,t} + K^{nd}_{i,t}\right)^{\nu}\right]^{\alpha} L^{1-\alpha}_{i,t} \tag{10}$$

In our formulation, α is the capital share, and ν is the span of control parameter as in Atkeson and Kehoe (2005). Durable and non-durable capital are assumed perfect substitutes in production.

Entrepreneur i's profit from running this firm at time t, $\Pi\left(\bar{A}_t, z_{i,t}, K^d_{i,t}, K^{nd}_{i,t}\right)$ is given as:

$$\begin{aligned} \Pi\left(\bar{A}_t, z_{i,t}, K^d_{i,t}, K^{nd}_{i,t}\right) &= \max_{L_{i,t}} y_{i,t} - W_t L_{i,t}, \\ &= \max_{L_{i,t}} \bar{A}_t \left[z^{1-\nu}_{i,t} \left(K^d_{i,t} + K^{nd}_{i,t}\right)^{\nu}\right]^{\alpha} L^{1-\alpha}_{i,t} - W_t L_{i,t}, \end{aligned} \tag{11}$$

in which W_t is the equilibrium wage rate, and $L_{i,t}$ is the amount of labor hired by entrepreneur i at time t.

It is convenient to write the profit function explicitly by maximizing labor in equation (11) and using the labor market-clearing condition $\int L_{i,t}di = 1$ to get:

$$L_{i,t} = \frac{z_{i,t}^{1-\nu}\left(K_{i,t}^{d} + K_{i,t}^{nd}\right)^{\nu}}{\int z_{i,t}^{1-\nu}\left(K_{i,t}^{d} + K_{i,t}^{nd}\right)^{\nu} di}, \tag{12}$$

so that entrepreneur i's profit function becomes:

$$\Pi\left(\bar{A}_t, z_{i,t}, K_{i,t}^{d}, K_{i,t}^{nd}\right) = \alpha \bar{A}_t z_{i,t}^{1-\nu}\left(K_{i,t}^{d} + K_{i,t}^{nd}\right)^{\nu}\left[\int z_{i,t}^{1-\nu}\left(K_{i,t}^{d} + K_{i,t}^{nd}\right)^{\nu} di\right]^{\alpha-1}. \tag{13}$$

Given the output of entrepreneur i, $y_{i,t}$, from equation (10), the total output of the economy is given as:

$$\begin{aligned} Y_t &= \int y_{i,t}di, \\ &= \bar{A}_t\left[\int z_{i,t}^{1-\nu}\left(K_{i,t}^{d} + K_{i,t}^{nd}\right)^{\nu} di\right]^{\alpha}. \end{aligned} \tag{14}$$

Capital Goods We assume that capital goods are produced from a constant-return-to-scale technology subject to a convex adjustment cost function. That is, capital production, also known as investment, I_t, costs $G\left(I_t, K_t^{d} + K_t^{nd}\right)$ units of consumption goods. Therefore, the aggregate resource constraint is:

$$C_t + I_t + G\left(I_t, K_t^{d} + K_t^{nd}\right) = Y_t. \tag{15}$$

We then take the standard assumption that the investment cost function is convex in investment capital ratio $\frac{I_t}{K_t}$ in which total capital stock as of time t, $K_t = K_t^{d} + K_t^{nd}$. Specifically:

$$G(I_t, K_t^{d} + K_t^{nd}) = \frac{\tau}{2}\left(\frac{I_t}{K_t^{d} + K_t^{nd}} - \bar{ik}\right)^2 (K_t^{d} + K_t^{nd}). \tag{16}$$

$\tau > 0$ is a parameter that indexes the marginal adjustment cost on a capital investment relative to the long-run mean investment capital ratio, $\bar{ik}$.

For model tractability, we also assume that at the aggregate level, the proportion of two types of capital is fixed, such that $\frac{K_t^{d}}{K_t} = \zeta$, and $\frac{K_t^{nd}}{K_t} = 1 - \zeta$ for which $\zeta > 0$. Also, the ratio of type-d to type-nd capital is normalized to $\zeta/(1-\zeta)$, and thus the state of the economy can be summarized by a single state variable.[16] This fixed proportion normalization can be achieved by specifying ϕ_t and $1 - \phi_t$ as the fraction of the new investment goods in producing type-d and type-nd capital, respectively (i.e., $\phi_t = (\delta_d - \delta_{nd})\zeta(1-\zeta)\frac{K_t}{I_t} + \zeta$). The aggregate stocks of type-d and type-nd

[16] Without this assumption, we must keep track of the ratio of two types of capital as an additional aggregate state variable; thus, we will not be able to achieve the recursion construction of the Markov equilibrium and the aggregation results as shown in Proposition 1.

capital are then:

$$K_{t+1}^{d} = (1-\delta_d) K_t^d + \phi_t I_t \tag{17}$$

$$K_{t+1}^{nd} = (1-\delta_{nd}) K_t^{nd} + (1-\phi_t) I_t. \tag{18}$$

4 Equilibrium Asset Pricing

4.1 Aggregation

Our economy is one with both aggregate and idiosyncratic productivity shocks. In general, we use the joint distribution of capital and net worth as an infinite-dimensional state variable in order to characterize equilibrium dynamics recursively. In this section, we follow Ai, Li, Li, and Schlag (2020a) and show that the aggregate quantities and prices of our model can be characterized without any reference to distributions. Given aggregate quantities and prices, quantities and shadow prices at the individual firm level can be directly computed using equilibrium conditions.

Distribution of Idiosyncratic Productivity At the aggregate level, the heterogeneity of idiosyncratic productivity can be conveniently summarized by a simple statistic: $Z_t = \int z_{i,t} di$. Given the law of motion of $z_{i,t}$ from equation (5) and the fact that entrepreneurs receive a liquidation shock with probability λ_t, we have:

$$Z_{t+1} = (1-\lambda_t) \int z_{i,t} e^{\varepsilon_{i,t+1}} di + \lambda_t \bar{z}_{t+1}.$$

Only a fraction $1-\lambda_t$ of entrepreneurs will survive until the next period, while the rest will restart with productivity of $\bar{z}_{t+1}$ in period $t+1$. As the law of motion of firms' idiosyncratic productivity shocks is time-invariant and that of liquidation shocks are specified as stationary processes, the cross-sectional distribution of $z_{i,t}$ converges to a stationary distribution.[17] We assume that $\varepsilon_{i,t+1}$ is independent of $z_{i,t}$ and can integrate out $\varepsilon_{i,t+1}$ and rewrite the above equation as:[18]

$$\begin{aligned} Z_{t+1} &= (1-\lambda_t) \int z_{i,t} E\left[e^{\varepsilon_{i,t+1}}\right] di \ + \lambda_t \bar{z}_{t+1} \\ &= (1-\lambda_t) Z_t e^{\mu_\varepsilon + \frac{1}{2}\sigma_\varepsilon^2} + \lambda_t \bar{z}_{t+1}, \end{aligned} \tag{19}$$

[17] In fact, the stationary distribution of $z_{i,t}$ is a double-sided Pareto distribution. Our model is therefore consistent with the empirical evidence regarding the power law distribution of firm size.

[18] The first line requires us to define the set of firms and the notion of integration in a mathematically careful way. Rather than reviewing the technical details, we refer readers to Feldman and Gilles (1985) and Judd (1985). Constantinides and Duffie (1996) use a similar construction in the context of heterogeneous consumers. See footnote 5 in Constantinides and Duffie (1996) for a more careful discussion on possible constructions of an appropriate measurable space under which the integration is valid.

in which the last equality follows from the fact that $\varepsilon_{i,t+1}$ is normally distributed. Clearly, if we choose the normalization $\bar{z}_{t+1} = \frac{1}{\lambda_t}\left[1-(1-\lambda_t)\,e^{\mu_\varepsilon+\frac{1}{2}\sigma_\varepsilon^2}\right]$ and initialize the economy by setting $Z_0 = 1$, then $Z_t = 1$ for all t. We assume as much for the rest of our paper.

Firm Profits We assume that $\varepsilon_{i,t+1}$ is observed at the end of period t when entrepreneurs plan the next period's capital. As we show in Section III of the Internet Appendix, this implies that entrepreneur i will choose $K^d_{i,t+1} + K^{nd}_{i,t+1}$ to be proportional to $z_{i,t+1}$ in equilibrium. Additionally, because $\int z_{i,t+1}di = 1$, we must have:

$$K^d_{i,t+1} + K^{nd}_{i,t+1} = z_{i,t+1}\left(K^d_{t+1} + K^{nd}_{t+1}\right), \tag{20}$$

in which K^d_{t+1} and K^{nd}_{t+1} are the aggregate quantities of type-d and type-nd capital, respectively.

The assumption that capital is chosen after $z_{i,t+1}$ is observed rules out capital misallocation and implies that total output does not depend on the joint distribution of idiosyncratic productivity and capital. This is because given idiosyncratic shocks, all entrepreneurs choose the optimal level of capital such that the marginal productivity of capital is the same for all entrepreneurs. Thus, $Y_t = \bar{A}_t\left(K^d_t + K^{nd}_t\right)^{\alpha\nu}\int z_{i,t}di = \bar{A}_t\left(K^d_t + K^{nd}_t\right)^{\alpha\nu}$. It also implies that the profit at the firm level is proportional to aggregate productivity such that:

$$\Pi\left(\bar{A}_t, z_{i,t}, K^d_{i,t}, K^{nd}_{i,t}\right) = \alpha\bar{A}_t z_{i,t}\left(K^d_t + K^{nd}_t\right)^{\alpha\nu},$$

and the marginal products of capital are equalized across firms for the two types of capital:

$$\frac{\partial}{\partial K^d_{i,t}}\Pi\left(\bar{A}_t, z_{i,t}, K^d_{i,t}, K^{nd}_{i,t}\right) = \frac{\partial}{\partial K^{nd}_{i,t}}\Pi\left(\bar{A}_t, z_{i,t}, K^d_{i,t}, K^{nd}_{i,t}\right) = \alpha\nu\bar{A}_t\left(K^d_t + K^{nd}_t\right)^{\alpha\nu-1}. \tag{21}$$

To derive equation (21), we take derivatives of firm i's output function in equation (10) with respect to $K^d_{i,t}$ and $K^{nd}_{i,t}$, and then impose optimality conditions in equations (12) and (20).

Intertemporal Optimality Having simplified profit functions, we can derive the optimality conditions for the entrepreneur's maximization problem in equation (9). We denote the marginal value of net worth for entrepreneur i using μ^i_t and let η^i_t be the Lagrangian multiplier associated with the collateral constraint in equation (4). The first-order condition with respect to $B_{i,t}$ implies:

$$\mu^i_t = E_t\left[\widetilde{M}^i_{t+1}\right]R_{f,t+1} + \eta^i_t, \tag{22}$$

for which we use the definition:

$$\widetilde{M}^i_{t+1} \equiv M_{t+1}[(1-\lambda_{t+1})\,\mu^i_{t+1} + \lambda_{t+1}]. \tag{23}$$

We find that one unit of net worth allows an entrepreneur to reduce one unit of borrowing, the present value of which is $E_t\left[\widetilde{M}_{t+1}^i\right] R_{f,t+1}$, and relaxes the collateral constraint, the benefit of which is measured by η_t^i.

Similarly, the first-order condition for $K_{i,t+1}^d$ is:

$$\mu_t^i = E_t\left[\widetilde{M}_{t+1}^i \frac{\frac{\partial}{\partial K_{i,t+1}^d}\Pi\left(\bar{A}_{t+1}, z_{i,t+1}, K_{i,t+1}^d, K_{i,t+1}^{nd}\right) + (1-\delta_d)\, q_{d,t+1}}{q_{d,t}}\right] + \theta(1-\delta_d)\eta_t^i. \qquad (24)$$

It implies that an additional unit of net worth allows an entrepreneur to purchase $\frac{1}{q_{d,t}}$ units of capital, which pays a profit of $\frac{\partial}{\partial K_{i,t+1}^d}\Pi\left(\bar{A}_{t+1}, z_{i,t+1}, K_{i,t+1}^d, K_{i,t+1}^{nd}\right)$ over the next period before it depreciates at rate δ_d. In addition, a fraction θ of type-d capital can be used as collateral to relax the borrowing constraint adjusted for its collateralizability. Similarly, the optimality with respect to the choice of type-nd capital follows:

$$\mu_t^i = E_t\left[\widetilde{M}_{t+1}^i \frac{\frac{\partial}{\partial K_{i,t+1}^{nd}}\Pi\left(\bar{A}_{t+1}, z_{i,t+1}, K_{i,t+1}^d, K_{i,t+1}^{nd}\right) + (1-\delta_{nd})\, q_{nd,t+1}}{q_{nd,t}}\right] + \theta(1-\delta_{nd})\eta_t^i. \qquad (25)$$

Recursive Construction of the Equilibrium In our model, entrepreneurs have different levels of net worth. First, net worth depends on the entire history of idiosyncratic productivity shocks, as can be seen from equation (5) by which $z_{i,t+1}$ depends on $z_{i,t}$, which in turn depends on $z_{i,t-1}$ and so forth. Furthermore, net worth also depends on the need for capital, which relies on the realization of the next period's productivity shock. Therefore, the marginal benefit of net worth, μ_t^i, and the tightness of the collateral constraint, η_t^i, generally depend on an individual firm's entire history. We next show that despite the heterogeneity in net worth and capital holdings across firms, our model permits an equilibrium in which μ_t^i and η_t^i are equalized across firms, and that aggregate quantities can be determined independently of the distribution of net worth and capital.

In addition, assumptions that type-d and type-nd capital are perfect substitutes in production and that the idiosyncratic shock $z_{i,t+1}$ is observed before the decisions on $K_{i,t+1}^d$ and $K_{i,t+1}^{nd}$ both greatly simplify our model equilibrium. As a result, the marginal product of both types of capital are equalized within and across firms as shown in equation (21), and μ_t^i and η_t^i are no longer firm-specific according to equations (22) to (25). Intuitively, as the marginal product of capital depends only on the sum of $K_{i,t+1}^d$ and $K_{i,t+1}^{nd}$, entrepreneurs only choose the total amount of capital that equalize marginal product across firms. Depending on the specific borrowing need when $z_{i,t+1}$ is observed before $t+1$, an entrepreneur then determines $K_{i,t+1}^d$ and $K_{i,t+1}^{nd}$ with realized $z_{i,t+1}$ consistent with the firm-specific collateral constraint.

We formalize this observation by constructing a recursive equilibrium in two steps. First, we show that aggregate quantities and prices can be characterized by a set of equilibrium functionals. Second, we further construct an individual firm's quantities from aggregate quantities and prices.

We make one final assumption: that aggregate productivity is given by $\bar{A}_t = A_t(K_t^d + K_t^{nd})^{1-\nu\alpha}$, in which $\{A_t\}_{t=0}^{\infty}$ is an exogenous Markov productivity process. On the one hand, this assumption follows Frankel (1962) and Romer (1986) and is a parsimonious way to generate endogenous growth. On the other hand, this assumption, when combined with recursive preferences, increases the volatility of the pricing kernel, as in the literature on long-run risk models (see, e.g., Bansal and Yaron (2004) and Kung and Schmid (2015)). From a technical point of view, this assumption means that equilibrium quantities are homogenous of degree one in the total capital stock, $K_t = K_t^d + K_t^{nd}$, and equilibrium prices do not depend on K_t. It is therefore convenient to work with normalized quantities.

To begin, we denote a generic variable in current period as X and in future period as X' and then let the lowercase variables denote aggregate quantities normalized by the current total capital stock; for instance, the current period aggregate net worth n denotes aggregate net worth N normalized by the total capital stock K. Abstracting from the time indexation, the equilibrium objects of our model include the normalized consumption, $c(A,\lambda,n)$, investment, $i(A,\lambda,n)$, the marginal value of net worth, $\mu(A,\lambda,n)$, the Lagrangian multiplier on the collateral constraint, $\eta(A,\lambda,n)$, the price of type-d capital, $q_d(A,\lambda,n)$, the price of type-nd capital, $q_{nd}(A,\lambda,n)$, and the risk-free interest rate, $R_f(A,\lambda,n)$ as functions of the realized exogenous state variables A and λ, as well as the endogenous state of normalized aggregate net worth, n.

We can define the growth rate of total capital stock as:

$$\Gamma(A,\lambda,n) \equiv \frac{K'^d + K'^{nd}}{K^d + K^{nd}} = (1-\delta_{nd}) + (\delta_{nd} - \delta_d)\zeta + i(A,\lambda,n)$$

Then the law of motion of the endogenous state variable n follows from equation (8):[19]

$$\begin{aligned} n' &= (1-\lambda'+\lambda'\chi)\left[\ \alpha A' + \zeta(1-\delta_d)\,q_d(A',\lambda',n') + (1-\zeta)(1-\delta_{nd})\,q_{nd}(A',\lambda',n')\ \right] \\ &\quad -(1-\lambda')\frac{b(A,\lambda,n)R_f(A,\lambda,n)}{\Gamma(A,\lambda,n)}. \end{aligned} \tag{26}$$

Given optimal consumption and capital growth rates, we obtain the normalized utility of the household as the functional fixed point of:

$$u(A,\lambda,n) = \left\{(1-\beta)c(A,\lambda,n)^{1-\frac{1}{\psi}} + \beta\Gamma(A,\lambda,n)^{1-\frac{1}{\psi}}\left(E[u(A',\lambda',n')^{1-\gamma}]\right)^{\frac{1-\frac{1}{\psi}}{1-\gamma}}\right\}^{\frac{1}{1-\frac{1}{\psi}}}.$$

[19]We make use of the property that the ratio of K_t^d over K_t^{nd} is always equal to $\zeta/(1-\zeta)$, as implied by the laws of motion of the capital stock for both types.

The stochastic discount factors can be rewritten as:

$$M' = \beta\left[\frac{c(A',\lambda',n')\Gamma(A,\lambda,n)}{c(A,\lambda,n)}\right]^{-\frac{1}{\psi}}\left[\frac{u(A',\lambda',n')}{E\left[u(A',\lambda',n')^{1-\gamma}\right]^{\frac{1}{1-\gamma}}}\right]^{\frac{1}{\psi}-\gamma}, \tag{27}$$

$$\widetilde{M}' = M'[(1-\lambda')\mu(A',\lambda',n')+\lambda']. \tag{28}$$

We next construct a Markov equilibrium for which all prices and quantities at the aggregate level are functions of the state variables (A,λ,n). For simplicity's sake, we assume that the initial idiosyncratic productivity across all firms satisfies $\int z_{i,1}di = 1$, the initial aggregate net worth is N_0, aggregate capital holdings start with $\frac{K_1^d}{K_1^{nd}} = \frac{\zeta}{1-\zeta}$, and a firm's initial net worth satisfies $n_{i,0} = z_{i,1}N_0$ for all i. The full equilibrium of our model then can be characterized as a set of aggregate quantities, $\{C_t, B_t, \Pi_t, K_t^d, K_t^{nd}, I_t, N_t\}$, individual entrepreneur choices, $\left\{K_{i,t}^d, K_{i,t}^{nd}, L_{i,t}, B_{i,t}, N_{i,t}\right\}$, and prices $\left\{M_t, \widetilde{M}_t, W_t, q_{d,t}, q_{nd,t}, \mu_t, \eta_t, R_{f,t}\right\}$ such that, given prices, quantities satisfy the household's and the entrepreneurs' optimality conditions, the market-clearing conditions, and relevant resource constraints. The following proposition provides details regarding the recursive stochastic equilibrium of our model.

Proposition 1. *(Markov Equilibrium)*

Suppose there exists a set of equilibrium functionals $\{c(A,\lambda,n), u(A,\lambda,n),, b(A,\lambda,n), i(A,\lambda,n), \mu(A,\lambda,n), \eta(A,\lambda,n), q_d(A,\lambda,n), q_{nd}(A,\lambda,n), R_f(A,\lambda,n), \phi(A,\lambda,n)\}$ *satisfying the following set of functional equations:*

$$E\left[M'\middle| A,\lambda,n\right]R_f(A,\lambda,n) = 1, \tag{29}$$

$$\mu(A,\lambda,n) = E\left[\widetilde{M}'\middle| A,\lambda,n\right]R_f(A,\lambda,n) + \eta(A,\lambda,n), \tag{30}$$

$$\mu(A,\lambda,n) = E\left[\widetilde{M}'\frac{\alpha\nu A' + (1-\delta_d)q_d(A',\lambda',n')}{q_d(A,n)}\middle| A,\lambda,n\right] + \theta(1-\delta_d)\eta(A,\lambda,n), \tag{31}$$

$$\mu(A,\lambda,n) = E\left[\widetilde{M}'\frac{\alpha\nu A' + (1-\delta_{nd})q_{nd}(A',\lambda',n')}{q_{nd}(A,n)}\middle| A,\lambda,n\right] + \theta(1-\delta_{nd})\eta(A,\lambda,n), \tag{32}$$

$$\frac{n+b(A,\lambda,n)}{\Gamma(A,\lambda,n)} = \zeta q_d(A,\lambda,n) + (1-\zeta)q_{nd}(A,\lambda,n), \tag{33}$$

$$\eta(A,\lambda,n)\{b(A,\lambda,n) - \theta[\zeta(1-\delta_d)q_d(A,\lambda,n) + (1-\zeta)(1-\delta_{nd})q_{nd}(A,\lambda,n)]\Gamma(A,\lambda,n)\} = 0, \tag{34}$$

$$G'(i(A,\lambda,n)) = \phi(A,\lambda,n)q_d(A,\lambda,n) + (1-\phi(A,\lambda,n))q_{nd}(A,\lambda,n), \tag{35}$$

$$c(A,\lambda,n) + i(A,\lambda,n) + g(i(A,\lambda,n)) = A, \tag{36}$$

$$\phi(A,\lambda,n) = \frac{(\delta_d-\delta_{nd})(1-\zeta)\zeta}{i(A,\lambda,n)} + \zeta, \tag{37}$$

where the law of motion of n is given by equation (26), and the stochastic discount factors M' and $\widetilde{M}'$ are defined in equations (27) and (27). Then, equilibrium prices and quantities can be *constructed as follows, thereby constituting a Markov equilibrium:*

1. *Given the sequence of exogenous shocks* $\{A_t, \lambda_t\}$*, the sequence of* n_t *can be constructed using the law of motion in equation (26), and the normalized policy functions are constructed as:*

$$x_t = x\left(A_t, \lambda_t, n_t\right), \ \textit{for} \ x = c, u, b, i, \mu, \eta, q_d, q_{nd}, R_f, \phi,$$

   and are jointly determined by equations (29)-(37).

2. *Given the sequence of normalized quantities, aggregate quantities are constructed as:*

$$K_{t+1}^d = K_t^d(1-\delta_d) + \phi_t I_t, K_{t+1}^{nd} = K_t^{nd}\left(1-\delta_{nd}\right) + \left(1-\phi_t\right) I_t,$$
$$X_t = x_t \left[K_t^d + K_t^{nd}\right],$$

   for $x = c, i, b, n,\ X = C, I, B, N,$ *and all* t*.*

3. *Given the aggregate quantities, individual entrepreneurs' net worth follows from equation (7). Given the sequences* $\{N_{i,t}\}$*, the quantities* $B_{i,t}, K_{i,t}^d$ *and* $K_{i,t}^{nd}$ *are jointly determined by equations (3), (4), and (20). Finally,* $L_{i,t} = z_{i,t}$ *for all* i, t*.*

This proposition implies that we can solve for aggregate quantities first and then use the firm-level budget constraint and the law of motion of idiosyncratic productivity to construct the cross-section of net worth and capital holdings. Our construction of the equilibrium allows $\eta\left(A, \lambda, n\right) > 0$ for some values of (A, λ, n); that is, our general setup allows for occasionally binding constraints. Numerically, we resort to the parameterized expectation algorithm as outlined in Christiano and Fisher (2000) and solve the aggregate quantities and prices globally over the domain of state variables.

Importantly, type-d capital can perfectly substitute for type-nd capital in production and both types of capital are freely traded on the market; thus, the marginal product of capital must be equalized within and across firms. The trading of capital therefore equalizes the Lagrangian multiplier of financial constraints across firms. This is the key feature of our model that allows us to construct a Markov equilibrium without including the distribution of capital as a state variable.[20]

We provide additional interpretations on our equilibrium conditions. Equation (29) is the household's intertemporal Euler equation with respect to the choice of risk-free asset. Equation (30) is the firm's optimality condition for the choice of debt. Equations (31) and (32) are the firm's first-order conditions with respect to the choice of type-d and type-nd capital. Equation (33) is the budget constraint of firms. Equation (34) governs the condition of complementary slackness, which gives the endogenous upper limit of borrowing for each period. Equation (35) is the optimality condition for capital goods production, equation (36) is the aggregate resource constraint, and equation (37) separates the allocation of new investment into two types of capital. Proposition

[20]Because of these simplifying assumptions, our model is silent on why some firms are constrained and others are not.

1 implies that conditions in equations (29)-(37) are not only necessary but also sufficient for the construction of equilibrium quantities and prices.

4.2 User Cost, Down Payment, and Risk Sensitivity

Following Proposition 1, aggregate quantities and prices do not depend on the joint distribution of individual entrepreneur-level capital and net worth. In this section, we define the user costs of type-d and type-nd capital in the presence of collateral constraint and aggregate risks by extending the definition in Jorgenson (1963). The optimal decision to choose between type-d and type-nd capital is achieved when user costs of two types of capital are equalized. The definitions in this section clarify a novel *risk-premium channel* in equilibrium that affects the relative attractiveness between two types of capital, which has not been emphasized in the literature.

First, we provide the intuition about the trade-off underlying type-d versus type-nd decisions by comparing their user costs. The user cost of capital, $\tau_{h,t}$, $h \in \{d, nd\}$, is:

$$\tau_{h,t} \quad = \quad \vartheta_{h,t} - E_t \left[\frac{\widetilde{M}_{t+1}}{\mu_t} \left\{ q_{h,t+1} \left(1 - \delta_h\right) - R_{f,t+1} \frac{B_{h,t}}{K_{h,t+1}} \right\} \right], \tag{38}$$

We denote $B_{h,t}$ as the act of borrowing for financing type-h capital of amount $K_{h,t+1}$. User costs can be measured by the difference between the minimum down payment per unit of capital paid upfront, $\vartheta_{h,t} = \frac{q_{h,t}K_{h,t+1} - B_{h,t}}{K_{h,t+1}}$, which is the first term in equation (38), and the present value of the fractional capital resale value next period that cannot be pledged, which is the second term in the equation.

For simplicity's sake, we first define a shadow interest rate for borrowing among entrepreneurs, $R_{I,t}$, which is given by:

$$1 = E_t \left(\frac{\widetilde{M}_{t+1}}{\mu_t} \right) R_{I,t+1}. \tag{39}$$

Based on equation (22) and the definition in equation (39), we can obtain an interest rate spread, $\Delta_{f,t+1}$, between two interest rates:

$$\Delta_{f,t+1} = R_{I,t+1} - R_{f,t+1} = \frac{\eta_t}{\mu_t} R_{I,t+1}.$$

Given the occasionally binding constraint as in equation (4), we obtain a measure of aggregate slackness of the credit constraint of each period Δ_t such that:

$$\Delta_t = \theta - \frac{B_t}{[(1-\delta_d)q_{d,t}\zeta + (1-\delta_{nd})q_{nd,t}(1-\zeta)]K_{t+1}} \geq 0. \tag{40}$$

Thus, when all firms are financially constrained in a period, $\Delta_t = 0$.

As a result, we can simplify the user cost of financing for a unit of type-h capital as:

$$\begin{aligned}\tau_{h,t} &= q_{h,t}\left[1-(\theta-\Delta_t)(1-\delta_h)\right] \\ &\quad -(1-\delta_h)\,Cov_t\left(\frac{\widetilde{M}_{t+1}}{\mu_t}, q_{h,t+1}\right) - \frac{1}{R_{f,t+1}+\Delta_{f,t+1}}E_t\varphi_{h,t+1}. \end{aligned} \quad (41)$$

We obtain the second line while the second term in equation (38) is expanded using a covariance term. Factoring out the discount factor $\frac{1}{R_{f,t+1}+\Delta_{f,t+1}}$, the capital resale value for the next period can be summarized as $\varphi_{h,t+1}$ such that:

$$\varphi_{h,t+1} = (1-\delta_h)\left[q_{h,t+1} - R_{f,t+1}(\theta-\Delta_t)\right]. \quad (42)$$

Next, we derive the difference in the user costs of the two types of capital and show that three important wedges appear to drive our main mechanism that determines firms' trade-off between holding type-d and type-nd capital.

$$\tau_{d,t} - \tau_{nd,t} = (\vartheta_{d,t} - \vartheta_{nd,t}) + \Delta_{rp,t} - \frac{1}{R_{f,t+1}+\Delta_{f,t+1}}E_t\left[\varphi_{d,t+1} - \varphi_{nd,t+1}\cdot\right] \quad (43)$$

The first component in equation (43) denotes the down-payment differences highlighted in Rampini (2019), which appears to be positive in the sense that durable capital is more "expensive" for financing a higher down-payment. It directly affects the trade-off for substitution between durable and less durable capital. Our model, in particular, highlights an *additional* risk-premium wedge as captured by the second term, $\Delta_{rp,t}$. This wedge denotes the difference in the risk premium evaluated by entrepreneurs' stochastic discount factors for type-d versus type-nd capital because of different covariances between capital prices and the discount factor. In particular, this wedge follows that:

$$\Delta_{rp,t} = -(1-\delta_d)Cov_t\left(\frac{\widetilde{M}_{t+1}}{\mu_t}, q_{d,t+1}\right) + (1-\delta_{nd})Cov_t\left(\frac{\widetilde{M}_{t+1}}{\mu_t}, q_{nd,t+1}\right).$$

While substitution across asset durability affects capital prices, such price effects reflect the relative riskiness in general equilibrium, and effectively introduces additional variations to user cost differences across capital types and over time. As a result, this wedge delivers the co-movement of capital prices with stochastic discount factors, which generates risk exposures in stock returns. We show in equilibrium that adverse aggregate productivity and financial shocks tend to trigger severe financial frictions on all firms, and that firms will acquire less expensive and less durable capital. Hence, durable capital not only exhibits greater price cyclicality but its prices are also more sensitive to aggregate shocks. On average, $\Delta_{rp} > 0$ helps explain why durable capital can be considered increasingly more expensive relative to financing for less durable capital (i.e., its incremental risk exposure to aggregate shocks).

Conditional on the same discount factor, the third term in the expectation in equation (43) gives that:

$$E_t\left[\varphi_{d,t+1} - \varphi_{nd,t+1}\right] = (1-\delta_d)\, E_t\left[q_{d,t+1} - R_{f,t+1}(\theta - \Delta_t)\right] - (1-\delta_{nd})\, E_t\left[q_{nd,t+1} - R_{f,t+1}(\theta - \Delta_t)\right],$$

which denotes the difference in the expected capital resale value for the next period. For $\delta_d < \delta_{nd}$ and with higher durable capital price in equilibrium $q_{d,t} > q_{nd,t}$ on average, it can be easily shown that $E_t\left[\varphi_{d,t+1} - \varphi_{nd,t+1}\right] > 0$. This term thus reflects the marginal benefit of acquiring durable capital relative to non-durable capital. This relative benefit term partly offsets the higher down payment and greater price riskiness of durable capital to determine total relative user costs between durable and non-durable capital.

In summary, our decomposition exercises suggest that it is costly for a firm to buy durable capital for two reasons. First, acquiring durable capital may be relatively more costly because it requires a larger down payment. Second, given that aggregate shocks will trigger a firm's substitutabilities over asset durability, the greater risk sensitivities of more durable capital relative to that of less durable capital commands a positive risk premium wedge that makes durable capital more expensive in equilibrium. User cost differences that are driven by different down payments have been emphasized in Rampini (2019), while the additional wedge delivered by a risk premium component is a key novel channel that we highlight in our paper.

We then consider a special case that can explain our contribution more fully. Suppose the capital prices of both types are fixed over time; this can be achieved, for instance, if there is no adjustment cost for producing capital goods in our model. It then implies that:

$$\tau_{d,t} - \tau_{nd,t} = (\vartheta_{d,t} - \vartheta_{nd,t}) - \frac{1}{R_{f,t+1} + \Delta_{f,t+1}}\left[\varphi_{d,t+1} - \varphi_{nd,t+1}\right].$$

Importantly, in such a case, capital prices do not fluctuate, and risk sensitivities of capital prices do not affect user cost differentials; thus, the risk premium wedge disappears. The asset durability trade-off can be traced back to Rampini (2019), thereby shutting off the risk-premium channel after fixing the stochastic discount factor.

Therefore, we emphasize that our highlighted risk premium channel for affecting choices over asset durability naturally arises in the general equilibrium over business cycles. This premium channel operates as long as more durable capital exhibits greater risk sensitivities to aggregate shocks regardless of whether or not entrepreneurs' financial constraints are binding. It can be shown that down payment differences and relative benefits of resale values of durable capital are both greatly weakened when entrepreneurs' borrowings are constrained. Specifically, according to equation (41), for any given $q_{d,t}$ and $q_{nd,t}$, the binding constraint for $\Delta_t = 0$ reduces down payments of $\vartheta_{d,t}$ and $\vartheta_{nd,t}$ on both capital types. The relative marginal benefit of acquiring durable capital is less important as $\frac{1}{R_{f,t+1}+\Delta_{f,t+1}}$ is smaller when the constraint is binding for $\eta_t > 0$ and entrepreneurs borrow at a rate with a positive spread $\Delta_{f,t+1} > 0$ over the risk-free rate. With $\Delta_t = 0$, the resale value of both capital goods, $\varphi_{d,t+1}$ and $\varphi_{nd,t+1}$, will be smaller as well. The relative benefit will become less important in determining the substitutabilities of asset durability when adverse financial shocks hit. Hence, on relative terms, the risk-premium channel predominantly affects capital substitutabilities particularly when financial frictions are more severe.

In sum, we use this paper to highlight an additional risk premium channel by building a dynamic choice of asset durability into a general equilibrium model with financial frictions and aggregate risks. We show that because of the different risk sensitivities of durable and non-durable capital over business cycles driven by aggregate shocks, firms' decisions over durable vs. non-durable capital goods are additionally affected by a risk premium channel. More importantly, when financial frictions are more severe than those that bind entrepreneurs' borrowing, this channel is comparatively much stronger and determines firms' choices over asset durability.

4.3 Asset Pricing Implications

In this section, we study asset pricing implications of our model both at the aggregate and the firm level.

Asset Durability Spread at the Aggregate Level We first discuss the importance of differentiating between *levered* and the *unlevered* returns on durable and non-durable capital. Given that one unit of type h capital costs $q_{h,t}$ in period t and pays off $\Pi_{h,t+1} + (1-\delta_h)\, q_{h,t+1}$ in the next period, for $h \in \{d, nd\}$, unlevered returns therefore follow such that:

$$R_{h,t+1} = \frac{\alpha\nu A_{t+1} + (1-\delta_h)\, q_{h,t+1}}{q_{h,t}} \quad (h = d, nd). \tag{44}$$

The levered return on type-d (type-nd) capital is similarly defined by adjusting for the leverage ratio and net worth:

$$\begin{aligned} R^{Lev}_{h,t+1} &= \frac{\alpha\nu A_{t+1} + (1-\delta_h)\, q_{h,t+1} - R_{f,t+1}(q_{h,t} - n_t/\Gamma_t)}{n_t/\Gamma_t} \\ &= \frac{1}{1-\psi_{h,t}}\left(R_{h,t+1} - R_{f,t+1}\right) + R_{f,t+1}. \end{aligned} \tag{45}$$

in which n_t/Γ_t denotes the amount of internal net worth used to buy one unit of capital of a given type for the period $t+1$, thereby serving as the down payment. The financial leverage ratio specific to that capital type is thus defined as $\psi_{h,t} = \frac{q_{h,t}\Gamma_t}{n_t}$. Regarding the first line in equation (45), the numerator captures the next period's return to the type of capital after subtracting the debt financing repayment for buying that one unit of capital. Finally, we see that excess returns derived from levered returns and those of un-levered returns are governed by the following relation:

$$R^{Lev}_{h,t+1} - R_{f,t+1} = \frac{1}{1-\psi_{h,t}}(R_{h,t+1} - R_{f,t+1}). \tag{46}$$

Importantly, when firms' credit constraints are binding, we see that borrowing for acquiring durable capital incurs a greater leverage $\psi_{d,t} = \theta(1-\delta_d) > \psi_{nd,t} = \theta(1-\delta_{nd})$. This generically increases levered returns on financing for durable capital $R^{Lev}_{d,t+1}$ according to equation (45) and follows Ai, Li, Li, and Schlag (2020a) in that more durable capital is more collateralizeable. We therefore report both the levered and the unlevered returns along with their return spreads for asset pricing implications in the following section. Specifically, we show that durable capital indeed has more collateralizeablility value, but is also riskier in equilibrium.

Next, we derive and focus on the spread of expected unlevered returns on durable and non-durable capital investment. Combining the two Euler equations as of equations (31) and (32), we have:

$$E_t\left[\widetilde{M}_{t+1}R_{h,t+1}\right] = \mu_t - \theta(1-\delta_h)\eta_t.$$

and the return spread follows:

$$\begin{aligned}&E_t\left(R_{d,t+1} - R_{nd,t+1}\right)\\ =&-\frac{1}{E_t\left(\widetilde{M}_{t+1}\right)}\left(Cov_t\left[\widetilde{M}_{t+1}, R_{d,t+1}\right] - Cov_t\left[\widetilde{M}_{t+1}, R_{nd,t+1}\right]\right) - \Omega_t\end{aligned} \tag{47}$$

in which $\Omega_t = \frac{\theta(\delta_{nd}-\delta_d)}{E_t\left(\widetilde{M}_{t+1}\right)}\eta_t$. As shown in equation (47), the return spread between durable and non-durable capital at the aggregate level is driven by two components: the first term captures risk premium differences in the covariance of the stochastic discount factor and the payoff with respect to each type of capital, and the second term Ω_t gauges the portion of spread affected by the relative marginal gain from financing the durable capital relative to non-durable capital since the durable capital is more collateralizable (Ai, Li, Li, and Schlag, 2020a).

For the first component, according to equation (44), the main driving force of return spread differences between durable and non-durable capital comes from the resale price $(1-\delta_h)\, q_{h,t+1}$ rather than from the marginal product of capital $\alpha\nu A_{t+1}$, which is common for both capital types. If the price of type-d capital exhibits higher cyclicality, then it is more covaried with the stochastic discount factor and is thus more sensitive to aggregate shocks. We highlights this risk-premium channel when we discuss incentives for firms' optimization over asset durability. Hence, $R_{d,t+1}$ is more riskier than its counterpart $R_{nd,t+1}$, and the first term is positive.

As for the second term Ω_t, since $\delta_{nd} > \delta_d$, the marginal gain from the collateralizability value of durable capital is positive $\frac{\theta(\delta_{nd}-\delta_d)}{E_t\left(\widetilde{M}_{t+1}\right)} > 0$ as long as the borrowing constraint is binding for $\eta_t > 0$, and the return spread is therefore partly reduced because $\Omega_t > 0$. If the credit constraint is not binding for $\eta_t = 0$, then the risk-premium channel remains and delivers a positive return spread, for durable capital is relatively riskier while the collateralizeability channel is shut off for $\Omega_t = 0$.

When borrowing constraints are binding, the risk-premium channel is relatively stronger so that it largely determines the capital substitutabilities independently. The return spreads between durable and non-durable capital therefore are much more pronounced when financial frictions are more severe compared to times when credit constraints are not binding. To confirm as much, we use a quantitative model to show that the risk-premium channel is so strong that it even dominates the collateralizeability channel when entrepreneurs' are more financially constrained. Therefore, durable capital is riskier in equilibrium even though it has greater collateralizeability value than that of non-durable capital.

Asset Durability Spread at the Firm Level In our model, equity claims to firms can be freely traded among entrepreneurs. We define the equity return on an entrepreneur's net worth to be approximately $\frac{N_{i,t+1}}{N_{i,t}}$.[21] When the borrowing constraint is binding, we can use equations (3) and (7) and write out the return as below:

$$\begin{aligned} R_{i,t+1} &= \frac{\alpha\nu A_{t+1}\left(K_{i,t+1}^{d}+K_{i,t+1}^{nd}\right)+\left(1-\delta_{d}\right)q_{d,t+1}K_{i,t+1}^{d}+\left(1-\delta_{nd}\right)q_{nd,t+1}K_{i,t+1}^{nd}-R_{f,t+1}B_{i,t}}{N_{i,t}} \\ &= \frac{\vartheta_{d,t}^{i}}{N_{i,t}}R_{d,t+1}^{Lev}+\frac{\vartheta_{nd,t}^{i}}{N_{i,t}}R_{nd,t+1}^{Lev}. \end{aligned}$$

This expression has an intuitive interpretation: the firm's equity return is a weighted average of the levered returns on type-d capital, $R_{d,t+1}^{Lev}$, and the return on type-nd capital, $R_{nd,t+1}^{Lev}$. The weights $\frac{\vartheta_{d,t}^{i}}{N_{i,t}}$ and $\frac{\vartheta_{nd,t}^{i}}{N_{i,t}}$ are the fractions of the down payment for purchasing some amounts of durable capital and non-durable capital, respectively, in entrepreneur i's net worth such that $\frac{\vartheta_{d,t}^{i}}{N_{i,t}}+\frac{\vartheta_{nd,t}^{i}}{N_{i,t}}=1$. Given unlevered returns, it follows that the excess stock returns of firm i can be rewritten as follows:

$$R_{i,t+1}-R_{f,t+1}=\frac{\vartheta_{d,t}^{i}}{N_{i,t}}\frac{1}{1-\psi_{d,t}}(R_{d,t+1}-R_{f,t+1})+\frac{\vartheta_{nd,t}^{i}}{N_{i,t}}\frac{1}{1-\psi_{nd,t}}(R_{nd,t+1}-R_{f,t+1}).$$

Accordingly, as returns $R_{h,t+1}$ and leverages $\psi_{h,t}$ are common across all firms in our model, expected returns differ across firms only because firms' composition of nominal expenditure on type-d versus the type-nd capital are different. Such composition of nominal expenditure therefore can be effectively summarized by the measure of asset durability of a firm in our data. This parallel between our model and our empirical results allows our model to quantitatively reproduce the asset durability spread that we observe in our data.

[21] In Section III of the Internet Appendix, we recast the firm value in the form of $V^{i}\left(N_{i,t},z_{i,t+1}\right)=\mu\left(A_{t},\lambda_{t},n_{t}\right)N_{i,t}+\Theta\left(A_{t},\lambda_{t},n_{t}\right)\left(K_{t}^{d}+K_{t}^{nd}\right)z_{i,t+1}$. We show $\Theta_{t}=0$ when $\nu=1$ in equation (III.25). As in our calibration, ν is large and close to one, and we ignore the second part in firms' values for illustrative purposes here. In our quantitative evaluations in Section 5, we examine precisely defined returns on firms' equity.

5 Quantitative Model Predictions

In this section, we first calibrate our model and evaluate its ability to replicate key aggregate moments of both macroeconomic quantities and asset prices. We then investigate its performance in terms of quantitatively accounting for key features of firm characteristics and producing the asset durability premium in the cross-section. In particular, we highlight that firms optimally adjust the asset durability on the balance sheet between acquiring durable and non-durable capital over business cycles, which results in different risk sensitivities and price cyclicalities of two capital types in equilibrium. Such a risk-premium channel is thus the key mechanism that drives return spreads across asset portfolios sorted on asset durability. Importantly, our model finds that although durable capital has greater collateralizability value than non-durable capital, durable capital is much riskier in equilibrium.

5.1 Specification of Aggregate Shocks

We formalize the specification of the exogenous processes of aggregate shocks for our model economy. First, the aggregate productivity in natural logarithm $a \equiv \log(A)$ is:

$$a_t = a_{ss}\left(1 - \rho_A\right) + \rho_A a_{t-1} + \sigma_A \varepsilon_{A,t}, \tag{48}$$

in which a_{ss} denotes the steady-state value of a. In addition, following Ai, Li, and Yang (2020b), we introduce a second type of aggregate shock to the chance that entrepreneurs' net worth will be liquidated, λ_t. This shock originates directly from the financial sector, following Jermann and Quadrini (2012). We incorporate these extra shocks mainly to improve the quantitative performance of our model. As in all standard real business cycle models, it is hard to generate large enough variations in capital prices with just an aggregate productivity shock such that entrepreneurs' net worth is consistent with the data. Importantly, our model features the risk-premium channel that non-durable capital is less risky than durable capital over business cycles driven by both aggregate productivity and financial shocks.

Specifically, the shocks to entrepreneurs' liquidation probability directly affect entrepreneurs' discount rate, as can be seen from equation (27), which allows for stronger asset pricing implications.[22] We also note that technically $\lambda_t \in (0, 1)$. For brevity's sake, we set:

$$\lambda_t = \frac{\exp\left(x_t\right)}{\exp\left(x_t\right) + \exp\left(-x_t\right)},$$

and x_t itself follows an autocorrelated process:

$$x_t = x_{ss}(1 - \rho_x) + \rho_x x_{t-1} + \sigma_x \varepsilon_{x,t}.$$

[22] Macro models with financial frictions, as portrayed in Gertler and Kiyotaki (2010) and Elenev et al. (2021), use a similar device for the same reason.

We assume innovations to the two exogenous processes governed by:

$$\begin{bmatrix} \varepsilon_{A,t+1} \\ \varepsilon_{x,t+1} \end{bmatrix} \sim Normal\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho_{A,x} \\ \rho_{A,x} & 1 \end{bmatrix}\right),$$

in which parameter $\rho_{A,x}$ captures the correlation between these two shocks. Following Quadrini (2011) and Bigio and Schneider (2017), we assume a negative correlation $\rho_{A,x}$ in our calibration, which indicates that a negative productivity shock is associated with a positive discount rate shock. This is partly motivated from structural VAR estimations. In addition, the resource constraint in equation (15) implies a counter-factually negative correlation between consumption and investment growth.[23] Negative correlations of productivity shocks and liquidity shocks are therefore needed in our model framework to quantitatively generate a positive correlation between consumption and investment growth that is consistent with the data. We show in our Internet Appendix that such shock correlations barely affect the asset durability premium produced in our model.

5.2 Calibration

We calibrate our model to target data moments of annual frequency. To compute these data moments, we use macroeconomic data on a per capita basis from a long sample that ranges from 1930 to 2017. Our consumption, output, and physical investment data are from the Bureau of Economic Analysis (BEA). To complete cross-sectional analyses, we use several data sources at the micro-level that help us evaluate our model predictions, which we summarize in Section IV of the Internet Appendix.

Table 4 reports the list of parameters and the corresponding macroeconomic moments in our calibration procedure. We group our parameters into four blocks. In the first block, we list the parameters that we borrow directly from the literature. In particular, we set the relative risk aversion γ to 10 and the intertemporal elasticity of substitution ψ to 2. These are parameter values in line with the long-run risks literature (e.g., Bansal and Yaron (2004).) The capital share parameter, α, is set to 0.32, close to the number used in the standard RBC literature (e.g., Kydland and Prescott (1982).) The span of control parameter ν is set to 0.85, consistent with Atkeson and Kehoe (2005). We also set the discount factor $\beta = 0.984$ and the average annual entrepreneur exit probability $E(\lambda) = 0.12$ to jointly match the level of risk-free interest rate for household loans to about 1.2% in the data and set an average firm's life span to 10 years in Compustat. The elasticity parameter of the investment adjustment cost functions is set at $\tau = 7$, which is standard in the RBC literature and allows our model to achieve a reasonably large volatility of investment in line with our data.

[Place Table 4 about here]

[23]This is a classic problem shared by many neoclassical macroeconomic models with flexible prices. See discussions in Kiyotaki and Moore (2019).

We determine the parameters in the second block by matching a set of first moments of quantities and prices to their empirical counterparts. We first set the depreciation rates for durable and non-durable capital to be 0.05 and 0.19, respectively, which correspond to empirical estimates of a lower and upper bound across the refined capital categories that are based on our calculations of the BEA data. We then pick $\zeta = 0.645$, which delivers a total annual depreciation rate of weighted averages of approximately 10%. Given that the average consumption-to-investment ratio $E(C/I)$ is 4, we back out the average economy-wide productivity growth rate $E(A_{ss})$ to match a mean growth rate of the U.S. economy of 2% per year conditional on the depreciation rates of capital. We calibrate the remaining parameters related to financial frictions, namely, the collateralizability parameter, θ, and the transfer to entering entrepreneurs, χ, by jointly matching two moments: the median leverage ratio of 0.31 among U.S. non-financial firms in Compustat and the equity over total asset ratios of approximately 0.48 among younger and newer U.S. private firms aged less than 10 years (Dinlersoz, Kalemli-Ozcan, Hyatt, and Penciakova, 2018).

The parameters in the third block are based on the conversion of standard parameter values that we estimate using quarterly data. Based on quarterly estimates from Bayesian estimations of a structural model with both macroeconomic and financial blocks (Guerron-Quintana and Jinnai, 2019), we convert quarterly values to their annual counterparts associated with the exogenous processes.[24] The shock correlation is set to $\rho_{A,x} = -0.85$, which lies between the number of -0.75 as derived from the positive correlation between the abundance of credit supply and the aggregate productivity in Bigio and Schneider (2017). Also, this correlation is -1 as assumed in Ai, Li, Li, and Schlag (2020a).

The last block contains parameters related to idiosyncratic productivity shocks. We calibrate them to match the mean and standard deviation of the idiosyncratic productivity growth of financially constrained firms in our U.S. Compustat database.

5.3 Numerical Solution and Simulation

We briefly summarize our model's numerical solution in this subsection and relegate Section II of the Internet Appendix for additional details on our algorithm and implementation. In particular, we solve our model globally for aggregate quantities and prices by allowing the credit constraint to be binding only occasionally over time. Our solution involves two major steps. First, we solve the model featuring the aggregate dynamics of quantities and prices. Second, we take the firm's policy functions and simulate a large panel of firms subject to idiosyncratic shocks, so we may compute corporate behaviors and their return profiles across sorted portfolios.

Specifically, we follow Christiano and Fisher (2000) and apply the modified Parameterized Expectation Algorithm (PEA) to directly approximate all expectation terms on the Euler Equations

[24] The persistence parameters are pinned down by having $\rho_A = 0.9543^4 = 0.8294$ and $\rho_x = 0.9870^4 = 0.949$, respectively. The standard deviation of the liquidation shocks and that of the productivity shocks can be obtained such that $\sigma_x = 0.0949 \cdot \sqrt{\sum_{j=0}^{q=3} 0.9870^{2j}} = 0.1862$ and $\sigma_A = 0.0144 \cdot \sqrt{\sum_{j=0}^{q=3} 0.9543^{2j}} = 0.0269$.

using Chebyshev Polynomials. Conditional on states, the approximated functionals related to policy functions can easily back out the functional values of η_t, which indicate if the credit constraint is binding occasionally. It is important to note that abstracting away from a time-varying firm distribution, our model solution features results that all firms are either constrained at a time or unconstrained at another time along the simulation path. This saves the computational burden if the distribution of firms is a state variable but without sacrificing our model predictability on cross-sectional returns. For a given calibration and our predefined dimension of functional approximation exercises, our model can be solved very quickly and efficiently.

Once functional approximations are obtained for aggregate quantities and prices, we move to the simulation stage. For each simulation, we simulate the model for 200 periods of 10,000 firms, and drop the first 100 periods of simulated data. We then run 500 separate simulations and compute the averages of data moments aggregated across firms and for aggregation results conditional on sorted portfolios. Finally, we report the aggregate moments, the return spreads, and corporate ratios across portfolios from our model and compare them with our data.

5.4 Aggregate Moments

We first examine the quantitative performance of our model at the aggregate level and document our model's success in matching a wide set of conventional moments in macroeconomic quantities and asset prices. Most importantly, our model delivers a sizable asset durability spread at the aggregate level.

Table 5 reports the key moments of macroeconomic quantities (top panel) and those of asset returns (bottom panel), respectively, and compares them to their counterparts in the data when available. The top panel shows that the model simulated data are broadly consistent with the basic features of the aggregate macro-economy in terms of volatilities, correlations, and persistence of output, consumption, and investment. In sum, our model is as successful as neoclassical growth models in accounting for the dynamics of macroeconomic quantities.

[Place Table 5 about here]

With respect to the asset pricing moments (bottom panel), we make two observations. First, our model is reasonably successful in generating moments related to financial frictions and asset pricing at the aggregate level. In particular, it replicates a low and smooth risk-free rate, with a mean of 1.22% and a volatility of 0.48%. The equity premium and leverage ratio in this economy are 6.88% and 0.44, respectively, and broadly consistent with the empirical target of 5.71% and 0.31 in the data. Our model also delivers large levered and unlevered returns on acquiring durable capital (i.e., 10.79% and 6.14%.) Second, our model confirms that return differences between durable and non-durable capital investment are more pronounced when credit constraint is binding. This holds regardless of whether the durable capital spread is measured using levered returns or unlevered returns. Specifically, expected return differences between durable and non-durable capital investment are 7.05% (levered returns) and 3.16% (unlevered returns), respectively, when the collateral constraint is binding. As we are unable to directly uncover empirical moments on returns at the asset level from the BEA table, our model evaluates the asset durability spread against data that is only in the cross-section of portfolios.

5.5 Model Mechanisms

In this subsection, we numerically evaluate the performance of our quantitative model and further explore the model mechanisms that give rise to the asset durability premium.

First, we show that there is a risk-premium channel (i.e., equilibrium asset prices for more durable capital goods are more volatile over business cycles), which therefore commands a larger risk premium for holding such capital. Table 6 summarizes statistics that indicate that capital goods prices in our model economy are riskier. Specifically, we first simulate the aggregate time series and simply compute the average standard deviations of log capital prices of both types across model simulations. Our model generates more cyclical durable capital prices, which are unconditionally more volatile compared to that of non-durable capital. Next, we examine the source of this large price variability of durable capital by computing the covariance between the weighted stochastic discount factor $\widetilde{M}_{t+1}$ as in equation (27) and next period capital prices $q_{d,t+1}$ and $q_{nd,t+1}$ conditional on time t's information with simulated aggregate data. Our results in the third and fourth rows of the table suggest that durable capital prices are more negatively correlated with the stochastic discount factor. Since durable capital exhibits greater risk sensitivities to business cycles, a larger risk premium is associated with holding the durable capital. Finally, we compute the *elasticity* of log differences in capital prices with respect to changes in the liquidation probabilities in log, by which financial shocks are the primary triggers for credit constraints to be binding. Our model results suggest that, on average, durable capital prices are more responsive to financial shocks compared to those of non-durable capital goods. Therefore, across different measures, our model predicts that the price of durable capital is about three to four times more volatile than that of non-durable capital over business cycles, as measured by unconditional price volatility or by risk sensitivities driven by aggregate shocks. Hence, our quantitative model confirms the importance of our highlighted risk-premium channel in showing that durable capital is much riskier in equilibrium.

[Place Table 6 about here]

Second, we evaluate firms' efforts to replace durable capital using non-durable capital when constraints are binding (i.e., substitutabilities of asset durability.) Our first measure is the capital expense ratio on durable capital of capital goods as a fraction of total capitalization, $Expense_t = \frac{q_{d,t}K_{d,t}}{q_{d,t}K_{d,t}+q_{nd,t}K_{nd,t}}$ with and without a binding constraint. Results from the top panel of Table 7 clearly suggest that firms' balance sheets shift toward more non-durable capital when constraints are binding, which amounts to a reduction of 2.81% of capital expense on durable capital moving from an unconstrained to a constrained situation. Our model solution accommodates a constant share of durable over non-durable ratio in quantities for $K_{d,t} = \zeta K_t$ and $K_{nd,t} = (1-\zeta)K_t$. Such drops in durable capital expense at the aggregate level are mainly driven by relative price drops. Second, we examine only quantity differences measured by the "excess investment" measured by capital accumulation of durable relative to non-durable, i.e. $\frac{K_{d,t+1}-K_{nd,t+1}}{K_t} = \zeta\Gamma_t - (1-\zeta)\Gamma_t$, which factors out the impact of relative price changes and focuses on quantity substitution. Results from the bottom panel of Table 7 suggest that less capital investment goes to durable capital accumulation if firms are more financially constrained. This loss of investment in durable capital because of tightened constraints amounts to a 2.5% decrease from that under the unconstrained scenario. Therefore, our model highlights that the asset durability substitution between durable and non-durable capital is very consistent with greater price cyclicality of more durable capital on average. We further show in subsection 5.6 that asset durability substitution is indeed a result of aggregate shocks that bind credit constraints leading to greater price drops of more durable capital relative to less durable capital.

[Place Table 7 about here]

Next, we evaluate how important our risk-premium channel is to the point that durable capital investment commands a higher expected return in our model. Table 8 presents our model results when we fix capital prices to be constant over time. In particular, we fix these prices at their respective steady-state values as they are in our baseline model by which $q_d^{ss} > q_{nd}^{ss}$. By construction, the risk-premium channel is shut off. Hence, relative to our baseline model case, if acquiring durable capital now is not compensated for additional risk premium while durable capital is still more expensive for its larger down payment, then investing in durable capital investment is not an attractive option, for it fails to yield a higher expected return for entrepreneurs. Our counterfactual analysis suggests that expected return spreads between investing in durable relative to non-durable shrink and even turn negative on average when firms are unconstrained. When firms are more constrained, we see from equation (41) that the impacts of down payments and relative benefits between durable and non-durable capital are less pronounced; therefore, the expected return spread is somewhat less negative. In sum, the risk-premium channel is critically important in our model, both qualitatively and quantitatively, as it generates a large expected return spread for investing in durable capital relative to non-durable capital.

[Place Table 8 about here]

Finally, we compute the mean return spread reduction when financial constraint is binding, $\Omega_t = E[\theta\eta_t(\delta_{nd} - \delta_d)/E_t(\tilde{M})]$ as in equation (47), which measures the size of the capital collateralizeability effect that durable capital is somewhat less risky as it provides extra collateral value. The collateralizability differences between type-d and type-nd capital goods, therefore, partially offset the model return spread commanded by acquiring more durable capital. The reduction of return spread matters only when constraints are binding $\eta_t > 0$. When we load our baseline calibration, as shown in Table 5, we find that this effect is small and reduces the return spread by about 22 basis points, which accounts for a tiny share of 7% (3%) of our total durable spread of 7.05% (3.16%) as measured in levered (unlevered) returns on financing durable capital investment when constraints are binding. Therefore, our quantitative model results suggest that the risk-premium channel dominates the offsetting collateralizeability channel, regardless of the effects driven by leverage ratios.

5.6 Impulse Response Functions

We further show that the impacts of our model mechanism on asset pricing can be best illustrated by looking into the model-implied impulse response functions of quantities and prices in response to exogenous aggregate shocks.

[Place Figure 1 about here]

In Figure 1, we plot the percentage deviations of quantities and prices from the steady state in response to one-standard-deviation of aggregate productivity shocks for shock period 1 (i.e., the shock to a.) over a 20-period horizon. In particular, since our model allows for collateral constraints to be binding only occasionally, the steady state of the shadow value of relaxing the borrowing constraint η_t has factored in both binding and non-binding periods. Three observations are summarized as follows. First, a positive shock to a (top panel in the left column) works as a negative discount rate shock to entrepreneurs, and the shock leads to a relaxation of the collateral constraint as reflected by a drop in the Lagrangian multiplier, η (top panel in the right column).

Second, relaxed collateral constraints translate into positive growth in the aggregate investment (second panel in the left column). Upon a positive productivity shock, not only does an entrepreneur's net worth jump sharply (third panel in the left column), but the price of type-d capital also increases sharply (second panel in the right column). However, the price of type-nd capital rises with a smaller magnitude, in contrast to the price of type-d capital. This observation suggests that the price type-d presents higher risk sensitivities and greater price fluctuations driven by aggregate productivity shocks. The different risk profiles are also reflected in the different responses of the unlevered return on type-d capital, r_d, and that on type-nd capital, r_{nd} when we factor impacts of leverage changes. The return of type-d capital responds much more to productivity shocks than that of type-nd capital (third panel in the right column). All these findings are consistent with our key model mechanism on capital substitutabilities driven by a risk-premium factor.

Lastly and most importantly, we confirm the operation of capital substitutabilities in economic expansions, when firms are collectively less constrained, they will prefer "more expensive" type-d capital. We show the impulse response of durable capital expenditure as a fraction of total asset (i.e., Expense Ratio of $K_{d,t+1}$), reacting to a positive productivity shock (bottom panel in the left column). It shows that the aggregate acquisition of durable capital across all firms increases relative to share of non-durable capital expenditure. In addition, in terms of the quantities of investment in durable capital in excess of non-durable capital (bottom panel in the right column), we see more investment to support accumulating durable capital relative to non-durable capital when the economy sees positive aggregate productivity shocks. All these impulse responses reflect the key channel on asset durability substitutions exactly. This explains why the price and returns on type-d capital increases even more significantly, as shown in the second and third panel in the right column.

Next, we introduce one standard deviation positive shocks to raise the liquidation probability λ_t. We then present the impulse responses of these key variables of interest to such adverse financial shocks in Figure 2.

[Place Figure 2 about here]

First, a positive shock to x_t raises the likelihood of a firm being liquidated λ as of the shock period 1 shown in the figure (top panel in the left column). It then works as a positive discount rate shock to entrepreneurs, which leads to a tightening of the collateral constraint, and results in an increase in the Lagrangian multiplier, η (top panel in the right column.)

Second, tightened collateral constraints result in slumps both in investment (second panel in the left column) and in entrepreneurs' net worth (third panel in the left column). In addition, the price of type-d capital drops dramatically (second panel in the right column), although the price of type-nd capital tumbles only slightly. We also see drops in both the unlevered return on type-d capital, r_d, and that on type-nd capital, r_{nd}, although the former has relatively larger decreases (third panel in the right column). Overall, we see durable capital as a riskier asset than non-durable capital by exhibiting larger risk sensitivities in case of a bad liquidation shock.

Finally, impulse responses of the relative capital expenditure on durable capital and excess investments in durable capital accumulation again confirm capital substitutabilities effects with negative financial shocks. Intuitively, when firms are more constrained in recessions after a bad liquidation shock, they prefer acquiring "cheaper" type-nd capital. The economy starts spending more on non-durable capital relative to a share of the total capital (bottom panel in the left column). The capital accumulation using durable capital in excess of non-durable capital through investment also shrinks (bottom panel in the right column.) All these substitutions also rationalize the different risk profiles of durable and non-durable capital to financial shocks in addition to productivity shocks (the second and third panel in the right column).

In summary, our model-based impulse response functions of key variables to both aggregate shocks all suggest that returns on type-d capital, r_d respond much stronger than that on type-nd capital, r_{nd}, to aggregate shocks by exhibiting larger risk sensitivities. Hence, durable capital is indeed much riskier than non-durable capital over business cycles driven by both types of shocks; therefore, holding durable capital necessarily commands for a greater expected return spread.

5.7 Asset Durability Spread

We now turn to the implications of our model on the cross-section of asset durability-sorted portfolios. We simulate firms from the model, measure the durability of firm assets, and conduct the same asset durability-based portfolio-sorting procedure as in the data.[25] In Table 9, we report the average returns of sorted portfolios, along with several other characteristics from the data and those from the simulated model.

[Place Table 9 about here]

Table 9 first reports several other characteristics of the asset durability-sorted portfolios that inform the economic mechanism we emphasize in our model. First, not surprisingly, the asset durability measure is monotonically increasing across asset durability-sorted portfolios.[26] In addition, our model-based portfolios with largest durability and lowest durability exhibit very similar depreciation rates, 0.08 and 0.18, respectively, as compared to the depreciation rates of portfolios constructed in the data, 0.11 and 0.19, respectively. For each portfolio in between, the model-based depreciation rates are close enough to the data counterparts. This provides important validity of our model for studying the return spread across portfolios sorted by asset durability, even if we are not calibrating our model to target at the degree of asset durability for each portfolio. Second, as in the data, leverage is increasing in asset durability. This implication of our model is consistent with the data and the broader corporate finance literature (e.g. Ai, Li, Li, and Schlag (2020a)). However, the dispersion in leverage ratios in our model is slightly larger than in the data.

We next examine the asset durability premium in our model. As in the data, our simulated firms with high asset durability have a significantly higher average return than those with low asset durability. Quantitatively, our model produces a levered and unlevered asset durability spread of 4.34% and 1.32%, respectively. By factoring out leverage effects so we may focus on unlevered returns, we see that our model rationalizes about 30% of the return spread differences in the data (4.75%). Taking the average asset durability premium from the data, 5.01%, according to four different financial constraint measures from Panels A to D in Table 3. Our model thus accounts for more than 80% of the levered-return based spread in the data. Hence, regardless of measures, our model predicts a sizable and positive asset durability premium.

[25]In our simulation, extremely financially constrained firms might seek negative type-d capital by selling expensive capital, so they may acquire less expensive type-nd capital. Such a scenario could result in a negative accumulated net worth. To align with our empirical analysis, we enforce a restriction that type-d, type-nd capital, and net worth must be strictly positive for firms in our simulation. We then conduct the univariate portfolio sorting exercise, consistent with our empirical approach.

[26]Following the construction of the asset durability measure in Section 2, we define the asset durability in our simulation as the weighted average of the reciprocal of the depreciation rate with respect to durable and non-durable capital:

$$\text{Asset Aurability} = \frac{K_d}{K_d + K_{nd}} \times \delta_d^{-1} + \frac{K_{nd}}{K_d + K_{nd}} \times \delta_{nd}^{-1}. \tag{49}$$

In summary, given our highlighted model mechanism of asset durability substitutabilities driven by financial shocks that tighten credit constraints over business cycles, our model produces sizeable asset durability premium quite well. The size of the premium is determined by the difference in the risk covariance as well as by cyclical properties of prices of durable and non-durable capital. Firms holding more durable capital are riskier for extra risk sensitivities; therefore, equity returns on these firms require extra risk compensations.

6 Empirical Analysis

In this section, we present evidence on the fluctuation of asset durability over business cycles and across firms with different idiosyncratic productivity. Moreover, we validate that assets with higher durability exhibit greater price cyclicality, leading to cross-sectional variations in stock returns. Additionally, we employ a GMM test to demonstrate that our durability-sorted portfolios are negatively influenced by financial shocks, elucidating the underlying mechanism driving the asset durability premium. Furthermore, our subsequent analysis includes a comprehensive evaluation of asset pricing factors. We show that the positive correlation between asset durability and stock returns persists, even when accounting for established factors related to systematic risks, with specific control for the collaterizability premium. Moreover, we explore the interconnected relationship between durability, firm-level attributes, and future stock returns within the cross-section. We achieve this by using Fama and MacBeth (1973) regressions, which provide additional support for the validity of the positive correlation.

6.1 Price Cyclality and Asset Durability

First, we present supporting evidence for the allocation decision between durable and non-durable capital, as outlined in equation (III.23) in Section III of our Internet Appendix. As we discussed earlier, our model predicts that firms, especially those more financially constrained, prefer cheaper and less durable assets during recessions. To validate this prediction, we conduct a predictive regression in which the asset durability of firm i in period $t+1$ is regressed on the financial shock, proxied by the GZ credit spread. The model also includes controls for fundamentals, specifically accounting for the idiosyncratic productivity shock $\Delta z_{i,t}$, and industry fixed effects:

$$\text{Durability}_{i,t+1} = a + b_{\text{GZ}} \times \text{GZ}_t + c \times \Delta z_{i,t} + d \times \text{Controls}_{i,t} + \varepsilon_{it} \tag{50}$$

As depicted in Table 10, we present our results for financially unconstrained and constrained subsamples in Specifications 1 and 2. The coefficient decreases from −0.31 in Specification 1 to −0.50 in Specification 2. This suggests that the durability of financially constrained firms decreases with a positive realization of the financial shock, indicating a preference for cheaper, less durable assets when borrowing constraints are binding. This result aligns directly with our theoretical prediction in Section 5.5.

[Place Table 10 about here]

According to equation (III.23), when firms experience positive idiosyncratic productivity shocks, they expand production scales by acquiring more capital. However, financially constrained firms lack sufficient net worth to obtain durable assets, leading them to prefer less costly non-durable assets. To test this prediction, we conduct a contemporaneous regression in which the asset durability of firm i in period t is regressed on its idiosyncratic productivity shock $\Delta z_{i,t}$. This regression includes controls for fundamentals, time, and industry-fixed effects:

$$\text{Durability}_{i,t} = a + b \times \Delta z_{i,t} + c \times \text{Controls}_{i,t} + \varepsilon_{it} \tag{51}$$

Similarly, we run separate regressions for financially constrained and unconstrained firms in Specifications 3 and 4. Consistent with our prediction, we observe a significantly negative coefficient in Specification 4 for the constrained subsample, while Specification 3 for the unconstrained subsample shows an insignificant and almost zero coefficient. These results align with the allocation decision for durable and non-durable capital outlined in our model.

In summary, our empirical analysis provides robust evidence supporting key predictions from our model. This includes the observed price cyclicality among durable and non-durable assets, as well as the systematic choice of asset durability over business cycles and across different firms.

Next, as in economic downturns, financial conditions among firms tend to exacerbate, particularly due to the heightened binding nature of financial constraints. Simultaneously, more financially constrained firms gravitate towards acquiring "cheaper" and less durable assets, characterized by lower down payment requirements. Consequently, these preferred assets exhibit a lower degree of procyclicality in their pricing, rendering them less susceptible to risk compared to durable assets. Our model predicts that, in contrast to durable assets, less durable assets offer relatively lower risk, providing a form of insurance against aggregate shocks. Within this subsection, we present direct evidence illustrating the variance in price cyclicality and substantiating our model's projection that the capital price of a more durable asset displays greater sensitivity to macroeconomic shocks compared to that of less durable capital.

Our approach proceeds as follows: First, we quantify the logarithmic differences in price changes ($\Delta q_{h,t}$) for each asset using data sourced from the Bureau of Economic Analysis (BEA) National Income and Product Accounts (NIPA) tables.[27] To capture aggregate macroeconomic shocks, we employ the default premium and the GZ credit spread. In this context, a positive realization of these metrics represents heightened credit constraints during economic recessions.[28] In our next

[27]For further insights into price indexes related to structures, equipment, and intellectual property products, we refer to NIPA Table 5.4.4, 5.5.4, and 5.6.4 (https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=2).

[28]The default premium denotes the yield disparity between Moody's Seasoned Baa and Aaa corporate

step, we segment the overall dataset into high and low groups based on each asset's durability. We then compute the average logarithmic difference of price changes for each group. Finally, we gauge sensitivity by conducting regressions that regress the logarithmic difference of price changes within each group against the default premium and the GZ credit spread, as depicted below:

$$\Delta q_{h,t} = a + b_{\text{Macro}} \times \text{Macro}_t + \varepsilon_{h,t},\ h \in \{H, L\}, \tag{52}$$

in which $\Delta q_{h,t}$ denotes the log difference of price changes within the respective groups. The variable Macro_t represents the aggregate macroeconomic shock, which we proxy using the default premium and the GZ credit spread.

Our primary findings are presented in Table 11. Notably, Specifications 2 and 4 underscore the presence of a significantly negative coefficient on both the default premium and GZ credit spread within the high-asset-durability group. This outcome validates our model's prediction regarding price cyclicality. Specifically, the intensified constraints faced by firms during economic downturns compel them to opt for less durable assets. This decision, in turn, contributes to a decline in the pricing of durable assets.

[Place Table 11 about here]

In contrast, Specifications 1 and 3 unveil coefficients that lack statistical significance concerning aggregate macroeconomic shocks. This observation underscores the preference for cheaper, non-durable assets during economic contractions. Our empirical evidence, therefore, establishes that assets with higher durability present more price sensitivities across business cycles. Consequently, these assets face substantially greater exposure to aggregate macroeconomic shocks than their less durable counterparts. This pattern carries an asset pricing implication: firms that maintain a portfolio comprising assets with enhanced durability are positioned as riskier entities, expected to earn higher returns due to amplified cyclicality evident in their valuations.

6.2 Cash Flow Sensitivities of Asset Durability-sorted Portfolios

Our theoretical framework posits that the asset durability premium arises from the distinct price cyclicality exhibited by durable versus less durable capital. In our model, the household is not directly involved in stock trading. Consequently, variations in the expected returns of a firm's equity necessitate attributions to disparities in cash flows that accrue to entrepreneurs. In our next section, we quantify equity cash flows and empirically demonstrate at the portfolio level that firms with elevated asset durability display heightened sensitivity in their equity cash flows with respect to two alternative proxies for aggregate macroeconomic shocks: the default premium and the GZ credit spread.

bond yields. As outlined in Gilchrist and Zakrajšek (2012), the GZ credit spread represents the average cross-sectional credit spread on senior unsecured corporate bonds issued by nonfinancial firms. This GZ credit spread data is sourced from Simon Gilchrist's personal website.

Following Belo, Li, Lin, and Zhao (2017), we initiate this process by aggregating cash flow, represented by EBIT, across firms within a given portfolio. Subsequently, we normalize this cumulative value by the total lagged sales of the same portfolio. This normalization process culminates in the computation of the sensitivity, or loading, of the cash flow concerning the two aggregate macroeconomic shocks under consideration.[29] We present our comprehensive results in Table 12.

[Place Table 12 about here]

Table 12 outlines cash flow sensitivity concerning the default premium and the GZ credit spread. Notably, the sensitivity of asset-durability-sorted portfolios follows a discernible declining trend across portfolios, spanning from 0.43 (−0.89) to −0.75 (−1.57) in relation to the default premium (GZ credit spread.) It's noteworthy that the loading for the highest quintile portfolio emerges as both statistically significant and lower than that of the lowest quintile portfolio. Particularly striking is the disparity in cash flow sensitivities between these two extreme portfolios, yielding a t-statistic of −2.21 (−2.01). This finding once again underscores a central economic mechanism within our study: assets with lower durability serve as a form of insurance against aggregate shocks.

6.3 Market Price and Exposure of Macroeconomic Shocks

In this section, we explore several pivotal testable implications that bolster our risk-based rationale for the asset durability premium. Firstly, we employ the default premium and the GZ credit spread as proxies for financial shock. Secondly, we apply the generalized method of moments (GMM) test to demonstrate that our financial shock proxies manifest a negative price of risk within the cross-section of asset-durability-sorted portfolios. This outcome seamlessly aligns with the model prediction delineated in Section 5.6. Moreover, when combined with our finding that high-asset-durability firms' stock returns incur greater negative exposure to the negatively priced financial shock, we gain a better understanding of the core mechanism underpinning the asset durability premium.

Initially, we assess the negative pricing of risk in relation to financial shock proxies. As indicated by the consistent negativity evident in the impulse response functions depicted in Figure 1, these proxies validate our expectations. Subsequently, we next examine the exposure of asset-durability-sorted portfolios to the aforementioned shock.

Our model outlines a two-factor framework wherein the first factor pertains to the market excess return, while the second factor is associated with the financial shock. To evaluate the pricing of this second factor, we follow Cochrane (2005) (pages 256-257). Concluding our examination, we begin by specifying the stochastic discount factor (SDF) as follows:

[29]In untabulated outcomes, we explore alternative normalization measures (e.g., total assets, property, plant, and equipment) to compute sensitivity in relation to financial shock. Remarkably, the result remains robust and unchangeable to the chosen normalization method, consistently aligning with our findings presented in Table 12.

$$\text{SDF}_t = 1 - b_M \times \text{MKT}_t - b \times \text{Macro}_t, \tag{53}$$

This specification signifies that investors' marginal utility stems from two aggregate shocks: MKT_t represents the market factor within the conventional capital asset pricing model (CAPM), while Macro_t stands for the default premium (or GZ credit spread) that serves as our empirical proxy for the financial shock. We aim to test the sensitivity of b, which is contingent upon Macro_t and is proportionate to the price of macroeconomic risk, denoted by b.

To assess b, we employ the following set of test assets: our six asset-durability-sorted portfolios (as delineated in Table 3), six size-momentum portfolios, and five industry portfolios.[30] Subsequently, we estimate the generalized method of moments (GMM) using the following set of moment conditions:[31]

$$\text{E}[R_i^e] = -\text{Cov}(\text{SDF}_t, R_i^e), \tag{54}$$

which is the empirical equivalent to the Euler equation of our model, but with the conditional moments replaced by their unconditional counterparts. We essentially assess the ability of these macroeconomic shocks (i.e., Macro_t) to price test assets based on residuals of the Euler equation.

Moreover, we adhere to practices in the literature, such as those outlined in Papanikolaou (2011), Eisfeldt and Papanikolaou (2013), and Kogan and Papanikolaou (2014), to compute two statistics that facilitate cross-sectional fitting. These statistics encompass the sum of squared errors (SSQE) and the mean absolute percent errors (MAPE). Additionally, we calculate the J-statistic for the overidentifying restrictions of our model. An insignificantly low J-statistic implies the non-rejection of the null hypothesis of zero pricing errors.

In Panel A of Table 13, we provide outcomes of the CAPM and our two-factor SDF model. In Specification 1, we isolate the market risk's price of risk, which is notably significant. After we incorporate the market factor with the default premium in Specification 2 and the GZ credit spread in Specification 3 as our reference, we observe that the price of the default premium (GZ credit spread) is significant -1.00 (-0.29) and statistically significant at the 1% level.

To assess asset pricing errors, the CAPM (Specification 1) exhibits SSQE and MAPE values of 5.70% and 5.13%, respectively. Upon the introduction of the default premium (GZ credit spread) to our model in Specification 2 (Specification 3), these figures decrease to 5.50% (5.64%) and 5.04% (5.11%), respectively. Despite the statistically insignificant outcome of the J-test in the CAPM model, we find that including the default risk premium (GZ credit spread) effectively enhances model fitting by diminishing pricing errors. Notably, the JT difference test reveals statistical significance between the CAPM model and our two-factor model in Specifications 2 and 3.

In totality, augmenting the stochastic discount factor with the financial shock enhances the CAPM model's ability to price stock returns.

[30] This selection of test assets is in line with Belo et al. (2017) and Lin, Palazzo, and Yang (2020).

[31] For detailed insights into moment conditions, please refer to Table 13.

[Place Table 13 about here]

Our theoretical framework underscores that the asset durability premium hinges on the cyclicality of the marginal value concerning durable capital. In contrast, non-durable capital's less procyclical nature functions as insurance hedge against adverse economic conditions when firms face financial constraints. In Panels B of Table 13, we unveil the risk exposure of asset-durability-sorted portfolios (GMM-implied betas) to diverse factors in the SDF. Furthermore, we provide GMM-implied alphas.

Notably, our findings reveal that betas concerning the market factor ($\beta_{i,\mathrm{MKT}}$) display uniformity across asset-durability-sorted portfolios in both panels.[32] Significantly, we present a descending trend in $\beta^i_{\mathrm{Default}}$ (β^i_{GZ}) from the low-asset-durability portfolio to the high-asset-durability portfolio. This pattern showcases an increasing covariance with our proxy for the negatively priced financial shock.

These results robustly support our risk-based proposition: that high-asset-durability firms yield elevated expected stock returns by bearing more negative betas on the financial shock, a factor that is negatively priced.

Lastly, we observe that including the financial shock helps reduce both the economic magnitude and statistical significance of the alphas associated with asset-durability-sorted portfolios. These results help reinforce our risk-based hypothesis, elucidating the pricing discrepancies linked to asset durability.

6.4 Empirical Asset Pricing Tests

6.4.1 Asset Pricing Factor Regressions

In Section 6.4, we examine the degree to which the variability in asset durability predictability can be accounted for by conventional risk factors or firm characteristics recognized for predicting stock returns. Relatedly, we execute an array of asset pricing factor assessments in Table IA.1 in our Internet Appendix. These tests reveal that the observed positive relationship between asset durability and returns remains largely unaltered by established return factors that include other systematic risks. Our findings underscore that the dispersion of returns across portfolios classified based on asset durability resists assimilation by these risk factors. Notably, the alphas in the long-short portfolio retain their statistical significance. Consequently, the positive connection between asset durability and returns that we establish cannot be simply attributed to common risk exposure.

[32] We modify the code of Kan, Robotti, and Shanken (2013) to calculate test assets' alphas and t-statistics based on Chapter 12 of Cochrane (2005).

6.4.2 Firm-level Return Predictability Regressions

To further explore the asset-durability-return relationship, we employ Fama and MacBeth (1973) regressions as outlined in Section I.1.2 of our Internet Appendix, specifically in Table IA.2. We do so to dispel potential alternative explanations. The outcomes of these Fama-Macbeth regressions closely mirror our previous findings, particularly when we arrange portfolios based on asset durability. As shown in Table IA.2, asset durability continues to significantly and positively predict future stock returns. Most notably, this predictability remains robust even in the presence of established predictors for stock returns that are found in the literature. This resilience is evident even when all control variables are simultaneously incorporated for a comprehensive assessment.

7 Conclusion

Our paper emphasizes that durable capital is harder to finance not only for its greater down payment but also for its larger price risk sensitivities to financial frictions. We show that this general equilibrium price effect has critically important asset pricing implications for understanding firms' equity risk due to asset durability. With a novel metric to gauge asset durability based on firms' assets, we document a substantial return differential of 5% annually between firms with high asset durability and those with low asset durability. Considering firms' dynamic capital choices between choosing durable and non-durable capital, we develop a general equilibrium asset pricing model incorporating heterogeneous firms and occasionally binding collateral constraints. Our model predicts that durable asset prices exhibit greater cyclicality and larger risk exposure to aggregate shocks, which consequently leads to higher expected returns. This arises directly from the capital substitutability channel driven by tightened financial constraints such that firms opt for reduced durable asset holdings that can alleviate collateral constraints. Our model generates sizeable differential risk exposure across portfolios of asset durability, which helps rationalize the asset durability premium in the cross-section.

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Figure 1. Impulse Responses to 1 S.D. Productivity Shock

This figure plots the log-deviations from the steady state for quantities and prices associated with a one-standard-deviation positive shock to a_t in period 1. One period is a year. All parameters are calibrated as in Table 4.

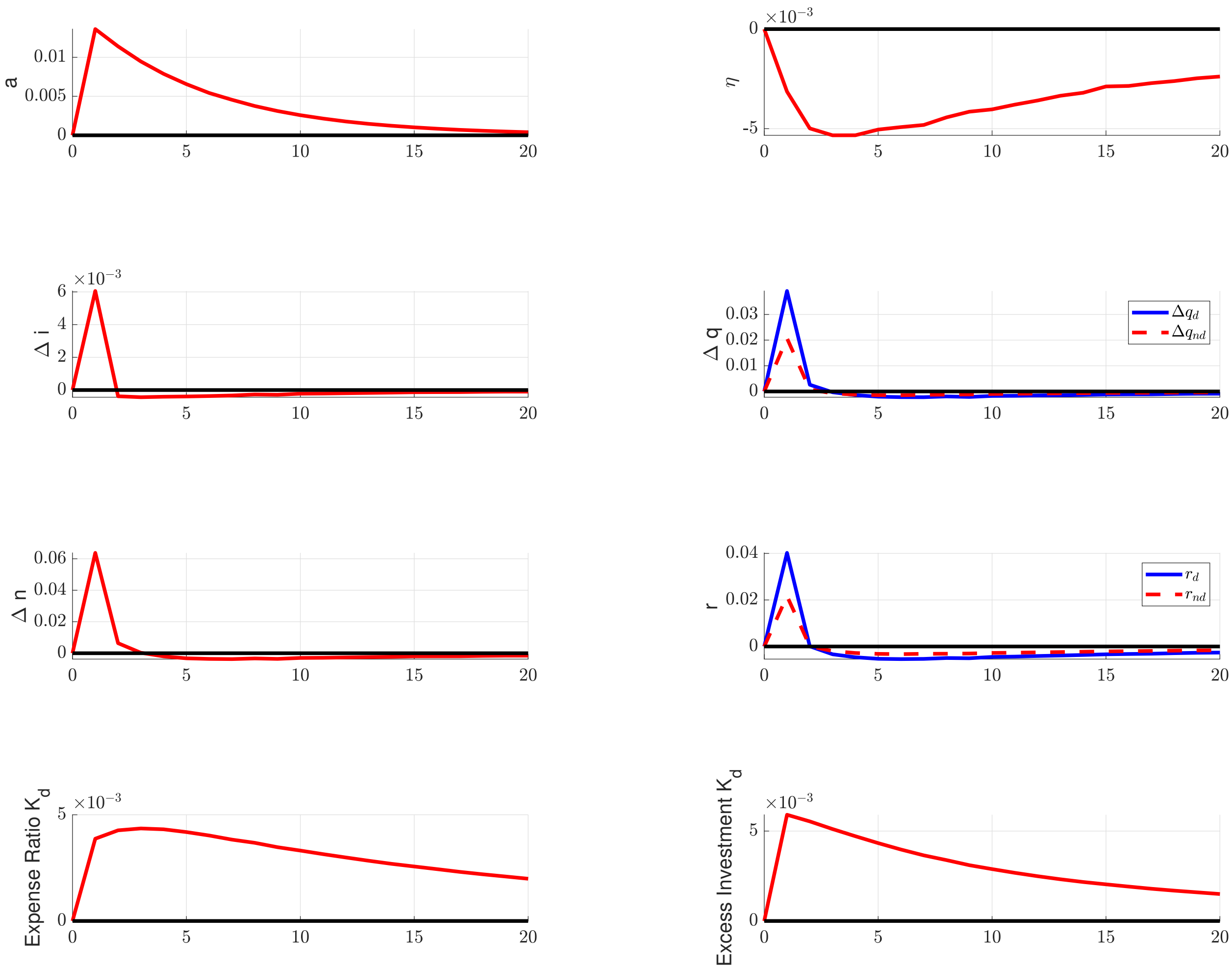

Figure 2. Impulse Responses to 1 S.D. Liquidation Shock

This figure plots the log-deviations from the steady state for quantities and prices associated with a one-standard-deviation positive shock to x_t in period 1. One period is a year. All parameters are calibrated as in Table 4.

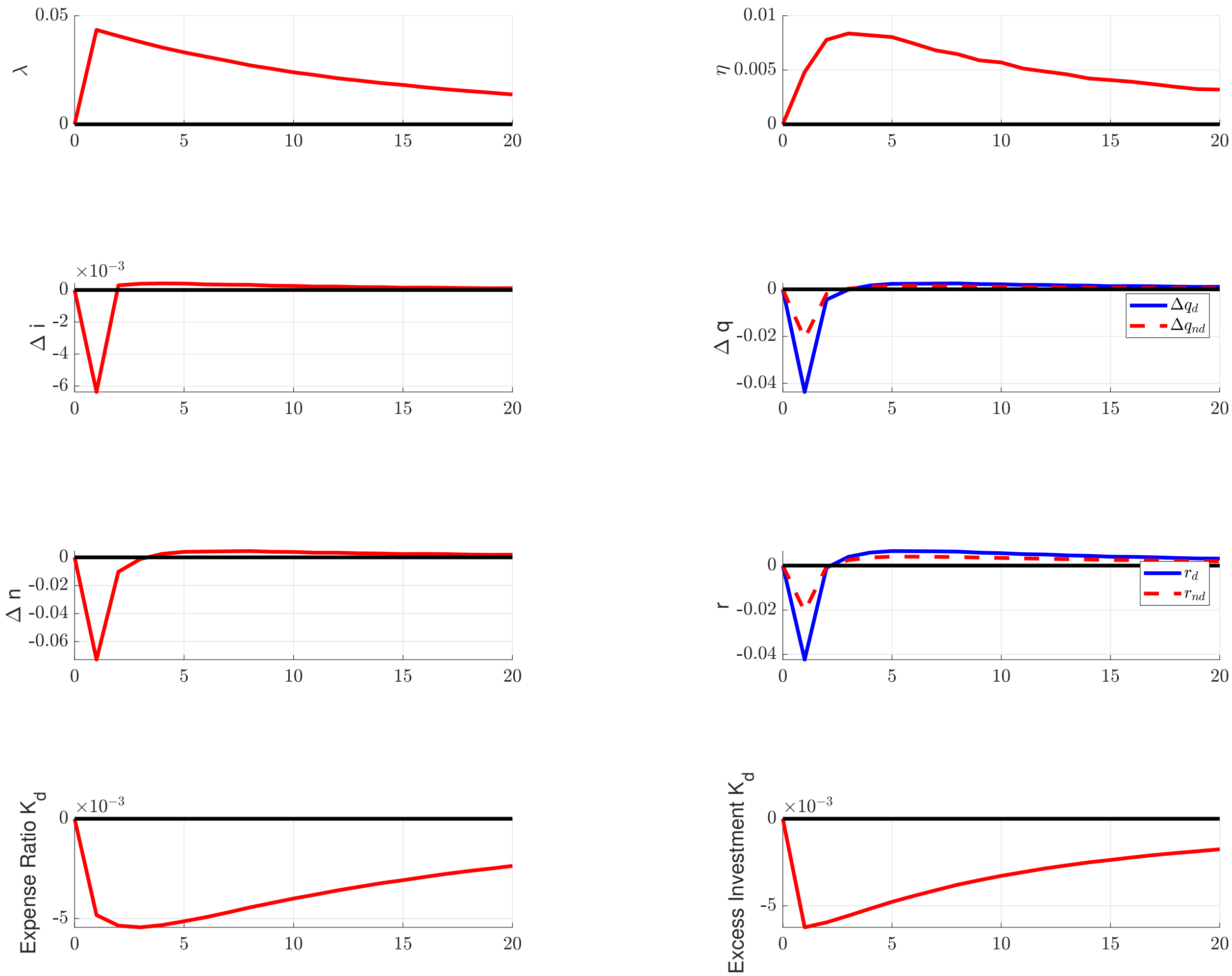

Table 1: Durability and Financial Constraints

This presents our regression coefficients of asset durability on different financial constraints, while also controlling for industry dummies at the NAICS 3-digit Code level. We provide definitions of variables in Table IA.5. All independent variables possess a mean of zero and a standard deviation of one, following winsorization at the 1st and 99th percentiles of their empirical distribution. Our reported t-statistics in parentheses are based on standard errors clustered at the firm level. Our sample omits utility, financial, public administrative, and public administrative industries, and covers the period from 1977 to 2016.

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Non-DIV	-1.75				-0.77		
[t]	-21.70				-10.75		
SA		-1.47				-1.37	
[t]		-31.98				-22.29	
WW			-1.08				-1.01
[t]			-22.10				-13.00
ROA				1.07	0.70	0.62	0.70
[t]				37.22	24.80	21.74	23.41
Log ME					0.12	-0.80	-0.71
[t]					2.77	-13.12	-9.69
Log B/M					0.42	0.01	0.09
[t]					12.96	0.20	2.52
I/K					-0.57	-0.50	-0.52
[t]					-20.01	-17.62	-17.00
Book Lev.					0.77	-0.42	-0.24
[t]					4.15	-2.20	-1.20
Cash/AT					0.50	0.48	0.49
[t]					12.81	12.47	12.20
Redp					-0.12	-0.10	-0.12
[t]					-1.16	-0.98	-1.17
TANT					3.84	3.88	3.83
[t]					59.23	60.01	58.10
Observations	130,059	130,059	120,135	129,924	99,292	99,292	94,299
R-squared	0.48	0.50	0.50	0.49	0.68	0.69	0.69
Controls	No	No	No	No	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 2: Summary Statistics

This table provides a comprehensive overview of summary statistics pertaining to both the main outcome variables and control variables within our sample. The precise definitions of asset durability and depreciation measures are outlined in Section 2.1. Panel A dissects the entire sample into constrained and unconstrained firms based on a dividend payment dummy (DIV), as classified by Farre-Mensa and Ljungqvist (2016), at the end of each June. We show the pooled means of these variables, weighted by firm market capitalization at fiscal year-end. Panel B showcases time-series averages representing the cross-sectional median of firm characteristics within constrained firms. These firms are segmented into five portfolios based on their asset durability relative to industry peers. We use NAICS 3-digit industry classifications to carry out our categorizations. Further definitions of our variables can be found in Table IA.5 of the Internet Appendix. Our sample spans the period from 1977 to 2016, and excludes financial, utility, and public administrative sectors.

	Panel A: Pooled Statistics		**Panel B: Firm Characteristics**				
	Const.	**Unconst.**	**Portfolios**				
Variables	**Mean**		**L**	**2**	**3**	**4**	**H**
Durability	12.66	16.54	7.69	9.99	11.45	14.24	18.00
Depreciation	0.17	0.13	0.19	0.16	0.15	0.13	0.11
Book Lev.	0.24	0.33	0.13	0.19	0.21	0.28	0.32

Table 3: Portfolios Sorted on Asset Durability

This table shows average excess returns for five portfolios sorted on asset durability across firms relative to their industry peers. To obtain these results, we use NAICS 3-digit industry classifications and rebalance portfolios at the end of every June. Our results reflect monthly data from July 1978 to December 2017 and exclude utility, financial, public administrative, and public administrative industries. We split the whole sample into financially constrained and unconstrained subsamples at the end of every June, as classified by dividend payment dummy, SA index, a rating dummy, and a WW index. We report average levered and unlevered excess returns over the risk-free rate E[R]-R_f, standard deviations Std, as well as report Sharpe ratios SR across five portfolios in constrained subsamples (Panel A) and in the whole sample (Panel B). We estimate standard errors by using the Newey-West correction. We also include t-statistics in parentheses and annualize portfolio returns by multiplying by 12. All returns, standard deviations, and Sharpe ratios have been annualized.

	Levered Returns						**Unlevered Returns**					
	Panel A: Constrained Subsample											
	L	**2**	**3**	**4**	**H**	**H-L**	**L**	**2**	**3**	**4**	**H**	**H-L**
	DIV											
E[R]-R_f (%)	5.39	9.57	9.34	9.03	12.32	6.93	3.73	6.91	6.84	6.90	8.93	5.20
[t]	1.48	2.81	2.81	2.92	3.62	2.86	1.32	2.52	2.77	2.86	3.57	3.17
Std (%)	26.79	25.32	24.81	24.05	24.09	11.8	20.25	19.84	18.79	18.60	17.34	9.22
SR	0.20	0.38	0.38	0.38	0.51	0.59	0.18	0.35	0.36	0.37	0.51	0.56
	SA											
E[R]-R_f (%)	4.53	7.59	7.97	8.39	9.63	5.10	2.94	5.81	5.40	5.60	6.62	3.68
[t]	1.12	1.89	1.98	2.35	2.77	2.54	1.07	2.75	2.54	3.19	4.05	2.13
Std (%)	24.45	23.55	24.34	21.09	20.70	11.58	18.77	18.07	18.57	14.7	14.33	9.97
SR	0.19	0.32	0.33	0.40	0.47	0.44	0.16	0.32	0.29	0.38	0.46	0.37
	Rating											
E[R]-R_f (%)	5.65	8.76	9.40	9.35	10.10	4.45	4.15	6.92	7.64	7.54	7.96	3.81
[t]	1.42	2.18	3.06	2.84	3.52	2.12	1.42	2.60	3.62	3.77	4.37	2.13
Std (%)	24.32	23.4	19.61	19.89	18.81	11.80	19.92	19.93	16.10	16.32	15.23	9.98
SR	0.23	0.37	0.48	0.47	0.54	0.38	0.21	0.35	0.47	0.46	0.52	0.38
	WW											
E[R]-R_f (%)	6.09	8.24	9.13	9.59	9.65	3.56	4.42	6.55	7.01	7.00	6.85	2.42
[t]	2.13	2.78	3.68	3.78	3.85	2.23	1.99	2.78	3.40	3.74	3.67	1.76
Std (%)	25.70	24.18	23.67	21.10	20.85	11.04	20.07	18.96	18.71	15.23	14.92	9.66
SR	0.24	0.34	0.39	0.45	0.46	0.32	0.22	0.35	0.37	0.46	0.46	0.25
	Panel B: Whole Sample											
E[R]-R_f (%)	7.36	8.10	8.12	8.65	8.79	1.44	4.85	5.30	5.82	5.60	5.75	0.90
[t]	2.70	3.49	3.26	4.17	3.55	1.03	2.6	3.29	3.58	3.65	3.62	0.98
Std (%)	19.25	16.75	15.14	15.15	17.37	8.72	12.96	11.4	10.53	10.77	11.4	5.94
SR	0.38	0.48	0.54	0.57	0.51	0.17	0.37	0.46	0.55	0.52	0.50	0.15

Table 4: Calibration

This table reports parameter values we used for our model calibrated to data of annual frequency.

Parameter	**Symbol**	**Value**
Relative risk aversion	γ	10
IES	ψ	2
Capital share	α	0.32
Span of control parameter	ν	0.85
Time discount factor	β	0.984
Death rate of entrepreneurs	$E(\lambda)$	0.12
Inv. adj. cost parameter	τ	7
Mean productivity growth rate	$E(\tilde{A})$	0.599
Durable capital dep. rate	δ_d	0.05
Non-durable capital dep. rate	δ_{nd}	0.19
Mean fraction of durable capital over total asset	ζ	0.645
Collateralizability parameter	θ	0.511
Entering entrepreneurs' net worth over capital ratio via transfers	χ	0.35
Persistence of TFP shocks	ρ_A	0.83
Persistence of liquidation shocks	ρ_x	0.95
S.D. of TFP shocks	σ_A	0.027
S.D. of liquidation shocks	σ_x	0.186
Shock correlation coefficient	$\rho_{A,x}$	-0.85
Mean idio. productivity growth	μ_ϵ	0.005
S.D. of idio. productivity growth	σ_ϵ	0.14

Table 5: Model Simulations and Aggregate Moments

This table presents annualized moments from our model simulations and the data whenever available. The model moments are calculated based on repetitions of sample simulations. We carry out our simulation at an annual frequency. Our reported moments pertain to these annual observations. The market return (R_M) reflects the return on entrepreneurs' net worth, incorporating endogenous financial leverage. R_h^{Lev} and R_h represent the returns on maximally levered and non-levered capital for capital type $h \in \{d, nd\}$, respectively, which we compute based on average financial leverage in the economy. Volatility, correlations, and first-order autocorrelation are denoted as $\sigma(.)$, $corr(.,.)$ and $AC1(.)$, respectively. The average reduction in return spread driven by the collateralizeability channel is denoted by $\Omega_t = E[\theta\eta_t(\delta_{nd} - \delta_d)/E_t(\tilde{M})]$ defined in equation (47). "Constrained" and "Unconstrained" refer to model moments computed using the subsamples of our simulation when the shadow value of borrowing constraint $\eta_t > 0$ and $\eta_t = 0$, respectively. Returns and return spreads are all expressed in percent (%).

Moments	**Data**	**Model**
$\sigma(\Delta y)$	3.05	2.96
$\sigma(\Delta c)$	2.53	2.46
$\sigma(\Delta i)$	10.30	6.45
$corr(\Delta c, \Delta i)$	0.39	0.6
$AC1(\Delta c)$	0.49	0.27
Leverage ratio	0.31	0.44
$E[R_M - R_f]$	5.71	6.88
$\sigma(R_M - R_f)$	20.89	8.29
$E[R_f]$	1.2	1.22
$\sigma(R_f)$	0.97	0.48
$E[R_d^{Lev}]$		10.79
$E[R_d^{Lev} - R_{nd}^{Lev}]$		5.24
$E[R_d^{Lev} - R_{nd}^{Lev}]$ (Constrained)		7.05
$E[R_d^{Lev} - R_{nd}^{Lev}]$ (Unconstrained)		2.71
$E[R_d]$		6.14
$E[R_d - R_{nd}]$		2.39
$E[R_d - R_{nd}]$ (Constrained)		3.16
$E[R_d - R_{nd}]$ (Unconstrained)		1.33
Ω_t		0.22
$\frac{\Omega_t}{E[R_d^{Lev} - R_{nd}^{Lev}]}$ (Constrained)		0.070
$\frac{\Omega_t}{E[R_d - R_{nd}]}$ (Constrained)		0.031

Table 6: Cyclicality of Equilibrium Capital Prices

This table presents model-implied moments measuring the unconditional and conditional variability of capital prices of both capital types. The model moments are calculated based on repetitions of sample simulations of annual frequency. Volatility, covariance, and correlation coefficient are denoted as $\sigma(.)$, $cov(.,.)$ and $corr(.,.)$, respectively. For each type of capital $h \in \{d, nd\}$, $log[q_{h,t}]$ denotes capital prices in natural logarithm. $\widetilde{M}_{t+1}$ is the augmented stochastic discount factor as defined in equation (27). λ_t denotes the probability of a firm being liquidated in period t.

Moments	**Model**
$\sigma(\log[q_{d,t}])$	0.149
$\sigma(\log[q_{nd,t}])$	0.067
$cov(q_{d,t+1}, \widetilde{M}_{t+1})$	-0.059
$cov(q_{nd,t+1}, \widetilde{M}_{t+1})$	-0.013
$corr(\Delta \log[\lambda_t], \Delta \log[q_{d,t}])$	-0.933
$corr(\Delta \log[\lambda_t], \Delta \log[q_{nd,t}])$	-0.861

Table 7: Substitutability of Durable vs. Non-durable Capital

This table presents model-implied moments measuring the degree of firms' capital substitution between asset durability concerning the tightness of borrowing constraints. The model moments are calculated based on repetitions of sample simulations of annual frequency. $E(\frac{q_{d,t}K_{d,t}}{q_{d,t}K_{d,t}+q_{nd,t}K_{nd,t}})$ denotes the average "expense ratio" which measures firm's relative capital expense on durable capital over total asset. $E(\frac{K_{d,t+1}-K_{nd,t+1}}{K_t})$ denotes the average "excess investment" in capital accumulation of durable relative to non-durable capital. "Constrained" and "Unconstrained" refer to model moments computed using the subsamples of our simulation when the shadow value of borrowing constraint $\eta_t > 0$ and $\eta_t = 0$, respectively. Relative change refers to the average drop of "expense ratio" and "excess investment" in durable capital when firms are constrained as compared to those under unconstrained time in relative terms and in percent.

Moments	**Model**
$E(\frac{q_{d,t}K_{d,t}}{q_{d,t}K_{d,t}+q_{nd,t}K_{nd,t}})$	0.791
$E(\frac{q_{d,t}K_{d,t}}{q_{d,t}K_{d,t}+q_{nd,t}K_{nd,t}})$ *(Constrained)*	0.782
$E(\frac{q_{d,t}K_{d,t}}{q_{d,t}K_{d,t}+q_{nd,t}K_{nd,t}})$ *(Unconstrained)*	0.804
Relative Change	-2.81%
$E(\frac{K_{d,t+1}-K_{nd,t+1}}{K_t})$	0.297
$E(\frac{K_{d,t+1}-K_{nd,t+1}}{K_t})$ *(Constrained)*	0.294
$E(\frac{K_{d,t+1}-K_{nd,t+1}}{K_t})$ *(Unconstrained)*	0.302
Relative Change	-2.50%

Table 8: Additional Model Results: Fixed Capital Prices

This table presents annualized moments from the model simulations for returns on capital investment. The model moments are calculated based on repetitions of sample simulations. We carry out our simulation at an annual frequency. We fix capital prices to be constant over time and at their respective steady state values as they are in our baseline model by which $q_d^{ss} > q_{nd}^{ss}$ when financial constraints are imposed. R_h^{Lev} and R_h represent the returns on maximally levered and non-levered capital for capital type $h \in \{d, nd\}$, respectively. "Constrained" and "Unconstrained" refer to model moments computed using the subsamples of our simulation when the shadow value of borrowing constraint $\eta_t > 0$ and $\eta_t = 0$, respectively.

Moments	**Model**
$E[R_d^{Lev}]$	8
$E[R_d^{Lev} - R_{nd}^{Lev}]$	-0.3
$E[R_d^{Lev} - R_{nd}^{Lev}]$ (Constrained)	-0.28
$E[R_d^{Lev} - R_{nd}^{Lev}]$ (Unconstrained)	-0.48
$E[R_d]$	5.38
$E[R_d - R_{nd}]$	-0.56
$E[R_d - R_{nd}]$ (Constrained)	-0.54
$E[R_d - R_{nd}]$ (Unconstrained)	-0.76

Table 9: Asset Durability Spread, Data, and Model Comparison

This table provides a comparison of moments between empirical data (Panel A) and model-simulated data (Panel B) at the portfolio level. Panel A presents statistics computed from the subset of financially constrained firms in the data, categorized by the dividend payment dummy (DIV). In Panel B, we conduct a model simulation and replicate the same portfolio sorting that we conducted with our empirical data. Both Panel A and Panel B present the time-series average of cross-sectional median firm characteristics, utilizing year-end values. These characteristics include asset durability, depreciation rate, book leverage, and levered and unlevered return on equity. Additionally, we report excess returns E[R]-R_f(%) (annualized by multiplying by 12, in percentage terms) for quintile portfolios sorted based on asset durability.

	L	**2**	**3**	**4**	**H**	**H-L**
			Panel A: Data			
Asset Durability	7.69	9.99	11.45	14.24	18.00	
Depreciation	0.19	0.16	0.15	0.13	0.11	
Book Lev.	0.13	0.19	0.21	0.28	0.32	
E[R]-R_f (%)	5.39	9.57	9.34	9.03	12.32	6.93
E[R]-R_f Unlevered (%)	4.09	7.43	6.77	7.29	8.84	4.75
			Panel B: Model			
Asset Durability	6.27	7.72	9.50	12.18	16.77	
Depreciation	0.18	0.17	0.15	0.12	0.08	
Book Lev.	0.22	0.25	0.28	0.33	0.41	
E[R]-R_f (%)	7.30	8.09	8.89	9.99	11.63	4.34
E[R]-R_f Unlevered (%)	5.49	5.92	6.27	6.61	6.81	1.32

Table 10: Durability, Financial Shock, and Idiosyncratic Productivity Shock

This table presents the regression coefficients of asset durability on a GZ credit spread and idiosyncratic productivity, while also controlling for industry dummies at the NAICS 3-digit Code level. We define variables in Table IA.5. All independent variables possess a mean of zero and a standard deviation of one, following winsorization at the 1st and 99th percentiles of their empirical distribution. The reported t-statistics in parentheses are based on standard errors clustered at the firm level. Our sample omits utility, financial, public administrative, and public administrative industries, and covers the period from 1977 to 2017.

	(1)	(2)	(3)	(4)
GZ	-0.31	-0.50		
[t]	-10.02	-14.96		
Δz	-0.00	-0.05	0.00	-0.03
[t]	-0.15	-2.14	-0.69	-2.11
Log ME	-0.06	-0.10	0.08	0.15
[t]	-1.06	-2.20	1.30	3.21
B/M	0.23	0.26	0.30	0.43
[t]	4.75	6.85	6.02	11.37
I/K	0.02	-0.02	-0.02	-0.05
[t]	0.41	-0.46	-0.20	-0.89
ROA	0.31	0.84	0.46	0.87
[t]	5.05	21.04	8.22	23.35
TANT	3.26	3.63	3.58	4.29
[t]	37.06	47.90	38.80	54.42
Book Lev.	-0.74	3.61	-0.42	5.75
[t]	-5.30	3.85	-3.00	5.98
Cash/AT	0.10	0.96	0.13	1.52
[t]	0.77	3.42	0.98	3.60
Observations	45,404	57,446	46,229	58,306
R-squared	0.55	0.50	0.50	0.49
Time FE	No	No	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Cluster SE	Yes	Yes	Yes	Yes

Table 11: Aggregate Shocks and Price Dynamics

This table shows the exposure of price dynamics to the default premium and a GZ spread. All estimates are based on the following time-series regressions:

$$\Delta q_{h,t+1} = a + b_{\text{Macro}} \times \text{Macro}_t + \varepsilon_{h,t},\ h \in \{H, L\},$$

in which $\Delta q_{h,t+1}$ represents the log difference of price changes in the high (H) and low (L) asset durability groups. Macro_t stands for the aggregate macroeconomic shock, which is proxied by the default premium and a GZ spread. To ensure robustness, we calculate standard errors using the Newey-West correction method. Corresponding t-statistics are reported within parentheses. Our sample spans from 1973 to 2017.

	(1)	**(2)**	**(3)**	**(4)**
	L	**H**	**L**	**H**
Default Premium	0.54	-0.55		
[t]	1.11	-3.97		
GZ Spread			0.31	-0.29
[t]			0.27	-2.01

Table 12: Cash Flow Sensitivity

This table presents the cash flow sensitivity of asset-durability-sorted portfolios to the default premium and a GZ spread. We compute normalized cash flow at the portfolio level by aggregating cash flow (EBIT) within each quintile portfolio and then normalizing it by lagged aggregate sales (SALE) of the specific portfolio. We conduct regressions of the portfolio-level normalized cash flow on the default premium and GZ spread, respectively. Our reported values are the estimated coefficients on normalized cash flow, accompanied by standard errors that we compute using Newey-West correction. Corresponding t-statistics are provided within parentheses. All regressions are performed on an annual basis, using data from 1979 to 2017.

	L	**2**	**3**	**4**	**H**	**H-L**
Default Premium	0.43	-0.63	-0.83	-0.36	-0.75	-1.18
[t]	0.34	-0.77	-0.76	-0.31	-0.60	-2.21
GZ Spread	-0.89	-0.86	-1.47	-1.09	-1.57	-0.68
[t]	-1.31	-1.84	-2.35	-1.58	-2.21	-1.97

Table 13: Estimating the Market Price of Risk

In Panel A, we present GMM estimates of parameters of the stochastic discount factor $SDF = 1 - b_M \times$ MKT $- b \times$ Macro by using the quintile portfolios sorted on asset durability. Macro refers to the default premium and a GZ credit spread. We conduct our normalization such that $E[SDF] = 1$ (See, e.g., Cochrane (2005)). We report t-statistics and computed errors using the Newey-West procedure adjusted for three lags. As a measure of fit, we report the sum of squared errors (SSQE), mean absolute pricing errors (MAPE), and the J-statistic of the overidentifying restrictions of our model. Given the Euler equation $\mathrm{E}[\mathrm{SDF} \times R_i^e] = 0$, SSQE and MAPE are based on each testing asset i's moment error u_i: $u_i = \frac{1}{T}\sum_{t=1}^{T}\left[\widehat{\mathrm{SDF}} \times R_{i,t}^e\right]$. SSQE and MAPE are defined as $\sum_{i=1}^{N} u_i \times u_i$ and $\frac{1}{N}\sum_{i=1}^{N}|u_i|$, in which N denotes the number of testing assets. In Panel B, we present GMM-implied testing portfolios' risk exposure (β^i_{MKT}, β^i_{Default}, and β^i_{GZ}) to market factor and financial shocks, together with GMM-implied pricing errors (α^i) in percentage.

	Panel A: Price of Risk		
	(1)	(2)	(3)
MKT	0.69	0.25	0.59
[t]	9.33	2.67	8.25
Default Premium		-1.00	
[t]		-7.25	
GZ Spread			-0.29
[t]			-2.05
SSEQ (%)	5.70	5.50	5.64
MAPE (%)	5.13	5.04	5.11
J-test	9.85	9.04	9.63
p	0.83	0.83	0.79
JT-Diff		31.59	21.83
p		0.03	0.05

	L	**2**	**3**	**4**	**H**	**H-L**
	SDF (MKT + Default Premium)					
β^i_{MKT}	27.79	24.64	21.43	21.64	22.24	-5.55
[t]	10.08	11.41	9.42	6.33	4.82	-1.63
β^i_{Default}	6.01	3.00	1.04	1.85	-0.53	-6.54
[t]	1.84	0.71	0.36	0.45	-0.09	-1.95
α^i	-3.32	0.32	-2.29	-1.66	2.95	-1.60
[t]	-1.60	0.14	-0.97	-0.70	1.36	-0.68
	SDF (MKT + GZ Spread)					
β^i_{MKT}	25.81	23.96	21.13	20.96	22.51	-3.30
[t]	23.13	8.47	8.09	6.50	7.37	-1.51
β^i_{GZ}	2.18	1.65	0.49	0.44	-0.03	-2.20
[t]	0.85	0.62	0.15	0.11	-0.01	-2.03
α^i	-4.03	0.26	-1.71	-1.91	2.96	1.91
[t]	-1.73	0.11	-0.73	-0.81	1.27	1.24