Internet Appendix for "The Asset Durability Premium" *

Dun Jia, Kai Li, and Chi-Yang Tsou

March 24, 2024

Contents

*Citation format: Jia, Li, and Tsou (2024) Internet Appendix to "The Asset Durability Premium." Any queries can be directed to the authors of the article.

I Supplemental Materials on Empirical Analysis

This section provides supplementary empirical analyses to support our model implications in the main text.

I.1 Empirical Asset Pricing Tests

I.1.1 Asset Pricing Factor Regressions

In this subsection, we consider the extent to which the variability in the average returns of the durability-sorted portfolios in our analysis can be explained by exposure to standard risk factors that are proposed by the Fama and French (2015) five-factor model, the Hou, Xue, and Zhang (2015) q-factor model, or, notably, the collateralizability factor identified in Ai, Li, Li, and Schlag (2020).[1]

To test the standard risk factor models, we perform time-series regressions of asset durability-sorted portfolios' excess returns on the Fama and French (2015) five-factor model (the market factor-MKT, the size factor-SMB, the value factor-HML, the profitability factor-RMW, and the investment factor-CMA), and of the collateralizability factor-COL (i.e., the long-short portfolio sorted on collateralizability) in Panel A, as well as on the Hou, Xue, and Zhang (2015) q-factor model (the market factor-MKT, the size factor-SMB, the investment factor-I/A, and the profitability factor-ROE), and the long-short portfolio sorted on collateralizability (COL) in Panel B, respectively. We use these time-series regressions to estimate the betas (i.e., risk exposures) of each portfolio's excess return on various risk factors and also to estimate each portfolio's risk-adjusted return (i.e., alphas in %). We annualize the excess returns and alphas in Table IA.1.

[Place Table IA.1 about here]

As presented in Table IA.1, the risk-adjusted returns (intercepts) of the high-minus-low portfolio sorted by asset durability remain notably large and statistically significant. These intercepts range from 8.14% for the Fama and French (2015) five-factor model in Panel A to 8.54% for the Hou, Xue, and Zhang (2015) q-factor model in Panel B. These intercepts are all at least 3.38 standard errors above zero, indicating high statistical significance. Additionally, the alphas estimated by both the Fama-French five-factor model and the HXZ q-factor model remain comparable to the durability spread observed in the univariate sorting (Table 3). Furthermore, the high-minus-low portfolio's returns exhibit significantly negative market

[1]The Fama and French factors are sourced from Kenneth French's data library (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html). The HXZ factors are obtained from the q-factors data library (http://globalq.org/index.html).

betas in relation to both the Fama and French (2015) five-factor model and the Hou, Xue, and Zhang (2015) q-factor model. However, these returns show insignificantly negative betas with respect to both models. Lastly, the asset durability spread cannot be explained by the collateralizability factor (COL), despite the association between higher asset durability and asset collateralizability.

Overall, the outcomes from our asset pricing factor tests detailed in Table IA.1 indicate that the variation in cross-sectional returns among portfolios categorized by asset durability cannot be absorbed by the Fama and French (2015) five-factor model, the HXZ q-factor model (Hou, Xue, and Zhang (2015)), or the collateralizability premium. Consequently, the elevated returns linked to asset durability are not explained by common risk factors. In our next subsection, we reinforce the association between asset durability and returns by utilizing Fama-Macbeth regressions.

I.1.2 Firm-level Return Predictability Regressions

We further investigate the predictive capacity of asset durability for cross-sectional stock returns using Fama-MacBeth cross-sectional regressions (Fama and MacBeth (1973)). This analytical method enables us to account for an extensive array of firm characteristics that predict stock returns. Moreover, it allows us to explore whether the positive relationship between asset durability and returns can be attributed to other established predictors at the firm level that are captured in the literature.[2]

We perform cross-sectional regressions for each month spanning from July of year t to June of year $t+1$ as expressed in the following equation:

$$R_{i,t+1} - R_{f,t+1} \;\; = \;\; a + b \times \text{Asset Durability}_{i,t} + c \times \text{Controls}_{i,t} + \varepsilon_{it}. \qquad \text{(I.1)}$$

Within each month, we regress the monthly returns of individual stocks (annualized by multiplying by 12) against the asset durability of year $t-1$ (reported by the end of December of year $t-1$), diverse sets of control variables known by the end of June of year t, and industry fixed effects. Our control variables encompass the natural logarithm of market capitalization at the end of each June (Size), which is deflated by the CPI index, the natural logarithm of the book-to-market ratio (B/M), the investment rate (I/K), profitability (ROA), R&D intensity (R&D/AT), organization capital ratio (OC/AT), book leverage, and industry

[2]Using this approach is advantageous compared to using portfolio tests, as the latter not only necessitate predetermined breaking points for sorting firms into portfolios, but also involve the selection of the number of portfolios. Moreover, since incorporating multiple sorting variables with distinct information about future stock returns through a portfolio approach is intricate, Fama-MacBeth cross-sectional regressions offer a reliable cross-validation mechanism.

indicators based on NAICS 3-digit industry classifications. To mitigate the impact of outliers, all independent variables are normalized to possess a zero mean and one standard deviation, following winsorization at the 1st and 99th percentiles.

[**Place Table IA.2 about here**]

Table IA.2 displays the outcomes of cross-sectional predictability regressions conducted on a monthly basis. The presented coefficient represents the mean slope derived from monthly regressions, while the accompanying t-statistics are obtained by dividing the average slope by its standard error across the time series. These Fama-MacBeth regression results are aligned with the patterns that we observe in portfolios organized with respect to asset durability.

Our Fama-MacBeth regression results corroborate our findings from portfolios sorted with respect to asset durability. To address the potential influence of leveraged positions, we incorporate a control for firm-level book leverage in each specification. In Specification 1, the relationship between asset durability and future stock returns is statistically significant and positive, characterized by a slope coefficient of 2.13, which is 3.44 standard errors from zero. This outcome underscores that the asset durability-return relation is predominantly driven by the leverage channel. For Specification 2, we introduce firm-level collateralizability as outlined by Ai, Li, Li, and Schlag (2020). Notably, the slope coefficient associated with asset durability remains significant and even increases in magnitude, even after we explicitly account for firm-level collateralizability. Simultaneously, collateralizability exhibits a significant and negative prediction for stock returns, which aligns with findings in Ai, Li, Li, and Schlag (2020).

We next explore potential alternative explanations grounded in systematic risks proposed by previous studies. Specifically, we investigate four alternative channels that could account for variations in our asset-durability-sorted portfolios:

Operating Leverage and Adjustment Costs: High-asset-durability firms might experience elevated expected returns due to the presence of higher fixed or adjustment costs associated with the downsizing of capital stock, especially during periods of economic decline. This aligns with the literature (e.g., Zhang (2005), Gu, Hackbarth, and Johnson (2018), Kim and Kung (2017)) which posits that firms with durable assets face challenges and costs when downsizing their production capacity, thus contributing to our observed pattern of returns in our analysis.

Output Durability: Firms with high asset durability often generate durable goods as outputs, making their cash flows more sensitive to business cycle fluctuations. This could contribute to observed differences in returns. This concept corresponds to the theory proposed by Gomes, Kogan, and Yogo (2009).

Financial Distress: Lower asset durability might expose firms to a higher risk of financial distress, resulting in comparatively lower average returns. This possibility is consistent with research by Griffin and Lemmon (2002), Bharath and Shumway (2008), and Campbell, Hilscher, and Szilagyi (2008).

In sum, these alternative explanations suggest that the observed return differentials could be driven by factors beyond asset durability, such as operating dynamics, output characteristics, and financial vulnerabilities.

If operating leverage (Zhang (2005) and Gu et al. (2018)) or adjustment costs (Kim and Kung (2017)) prove to be the driving factors behind the asset durability premium, we would then anticipate that this premium would diminish when we account for operating leverage in Specifications 3 and 4, or for asset redeployability in Specification 5. However, the significantly persistent positive slope coefficients on asset durability at the 1% level in these specifications indicate that the observed return predictability is not attributed to systematic risk that stems from either operating leverage or adjustment costs.

We also explore the concept of output durability as proposed by Gomes, Kogan, and Yogo (2009) and examine its relationship with our asset durability measure.[3] Gomes, Kogan, and Yogo (2009) posit that producers of durable goods experience cash flow sensitivity to aggregate economic fluctuations due to the procyclicality of demand for their products. This elevated sensitivity renders their stocks riskier and yields higher average returns. In Specification 6, we observe that firm-level asset durability continues to predict stock returns, even after we account for the Durable Output dummy that reflects a firm operates in durable goods producing industries. This persistence in positive predictability suggests that our asset durability measure encapsulates distinct information compared to that of output durability. However, we recognize that variations in stock returns that we highlight in Gomes, Kogan, and Yogo (2009) primarily stem from differences between durable and service industries (across industries). On the contrary, our asset durability's predictability revolves around disparities in firms' asset durability in relation to their industry peers (within the industry). Consequently, the concepts of output durability and capital durability complement each other, although they stem from different economic mechanisms.

For Specifications 7 through 10, we introduce the firm-level O index, the Z index, default probability, and failure probability as measures of a firm's financial distress, as proposed by Griffin and Lemmon (2002), Bharath and Shumway (2008), and Campbell, Hilscher, and Szilagyi (2008). Notably, we observe that the coefficients on asset durability remain significant and, if anything, are slightly more pronounced in magnitude when we explicitly account

[3] Detailed classifications for output durability are obtained from Motohiro Yogo's personal website (https://sites.google.com/site/motohiroyogo/).

for these firm-level financial distress measures. Our findings in Specifications 7 to 10 have important implications. Firstly, they underscore that the positive asset durability premium stands apart from the negative relation between distress and expected returns, which is commonly documented in the literature. These specifications reaffirm that asset durability's predictability is independent of financial distress and that it encompasses information that goes beyond what is captured by financial distress. Secondly, our theoretical framework may provide insights into the financial distress puzzle, suggesting that financially distressed firms exhibit lower risk and consequently lower average returns since they tend to use more economical non-durable assets and experience less price cyclicality.

In our final specification, Specification 12, we find that the predictability of asset durability for stock returns remains intact even when we account for all the known predictors and control variables together in a comprehensive analysis. This horse racing test demonstrates that these variables do not undermine the predictive power of asset durability. In summary, our findings suggest that asset durability's ability to forecast stock returns is distinct and not overshadowed by these established predictors.

II Computation Details on Model Solutions

To study asset pricing implications, we first solve the model regarding dynamics of aggregate prices and quantities only and then take policy functions to simulate a large panel of firms for computing return profiles. In this section, we describe our computational procedures for solving the model about aggregates.

Specifically, we use the modified Parameterized Expectation Algorithm (PEA) as in Christiano and Fisher (2000) to solve our model for the sequence of functional objects. We thus solve our model using a global method, which allows for occasionally binding constraints and distinguishes ours from the literature that imposes a binding constraint at the stochastic steady state. As we abstract away from a time-varying firm distribution, our model solution shows that all firms could be constrained or unconstrained in different times along the simulation path.

II.1 Recast of the Law of Motion for Ease of Computation

Our numerical implementation reduces the computational burden by avoiding the iterative root-finding that is extremely time-consuming but routinely associated with a dynamic programming problem. That is, our computation can be very iteratively solved for the root of an equilibrium functional $n^{prime}(A, \lambda, n)$ that fits the path of the law of motion per equation

(III.4).

Instead, we perform some change of variable that effectively reconstructs endogenous state variables by which the law of motion of net worth is no longer intertwined with equilibrium functionals. Specifically, we change the normalization of the total cost of borrowing $R_{f,t+1}B_t$ as of period $t+1$ using future capital stock of K_{t+1}, which gives $\tilde{b}_t = \frac{R_{f,t+1}b_t}{\Gamma_t}$. The redefined debt position $\tilde{b}_t$ thus enters the law of motion such that:

$$n_{t+1} = (1-\lambda_{t+1})(s_{t+1} - \tilde{b}_t) + \lambda_{t+1}\chi s_{t+1} \tag{II.1}$$

in which $s_{t+1} = \alpha\nu A_{t+1} + (1-\delta_d)\zeta q_{d,t+1} + (1-\delta_{nd})(1-\zeta)q_{nd,t+1}$. When we combine this with the balance sheet constraint $n_t + b_t = \Gamma_t(\zeta q_{d,t} + (1-\zeta)q_{nd,t})$, we have the law of motion refined over this redefined debt position, which directly builds on the predefined grids of $\tilde{b}_t$ without solving for any root functional.

$$\begin{aligned}\tilde{b}_t = &\frac{R_{f,t+1}}{\Gamma_t}(1-\lambda_t)\,\tilde{b}_{t-1} + R_{f,t+1}[\zeta q_{d,t} + (1-\zeta)q_{nd,t}] \\ &- \frac{R_{f,t+1}}{\Gamma_t}[1-\lambda_t(1-\chi)]s_t \end{aligned}\tag{II.2}$$

In particular, the occasionally binding borrowing constraint based on the redefined debt position is formulated as:

$$\tilde{b}_t \le R_{f,t+1}\theta[(1-\delta_d)\zeta q_{d,t} + (1-\delta_{nd})(1-\zeta)q_{nd,t}] \tag{II.3}$$

II.2 Recast of the Recursive Equilibrium

We then recast the model equilibrium conditions and solve a sequence of equilibrium functional $X(A_t, \lambda_t, \tilde{b}_{t-1})$ defined over a predetermined debt position $\tilde{b}_{t-1}$ and the aggregate states A_t and λ_t as of time t. We show that our recast model structure is not subject to time-consuming root-finding iterations. Similarly, we denote the generic variable in period t as X and X' for period $t+1$ and x and X to characterize a generic normalized and non-normalized quantity, respectively. The model equilibrium can be similarly rewritten as a set of a set of equilibrium functional $\{c\left(A,\lambda,\tilde{b}\right), \tilde{b}'(A,\lambda,\tilde{b}), i\left(A,\lambda,\tilde{b}\right), \mu\left(A,\lambda,\tilde{b}\right), \eta\left(A,\lambda,\tilde{b}\right), q_d\left(A,\lambda,\tilde{b}\right),$ $q_{nd}\left(A,\lambda,\tilde{b}\right), R_f\left(A,\lambda,\tilde{b}\right), \phi\left(A,\lambda,\tilde{b}\right), M'\left(A,\lambda,\tilde{b}\right), \widetilde{M}'\left(A,\lambda,\tilde{b}\right), n\left(A,\lambda,\tilde{b}\right), \Gamma\left(A,\lambda,\tilde{b}\right)\}$ satisfying the following set of functional equations:

$$M' = \beta \left[\frac{c\left(A', \lambda', \tilde{b}'\right) \Gamma\left(A, \lambda, \tilde{b}\right)}{c\left(A, \lambda, \tilde{b}\right)} \right]^{-\frac{1}{\psi}} \left[\frac{u\left(A', \lambda', \tilde{b}'\right)}{E\left[u\left(A', \lambda', \tilde{b}'\right)^{1-\gamma} \right]^{\frac{1}{1-\gamma}}} \right]^{\frac{1}{\psi}-\gamma}, \tag{II.4}$$

$$\widetilde{M}' = M'[(1-\lambda')\,\mu\left(A', \lambda', \tilde{b}'\right) + \lambda'], \tag{II.5}$$

$$E\left[M' \middle| A, \lambda, \tilde{b} \right] R_f\left(A, \lambda, \tilde{b}\right) = 1, \tag{II.6}$$

$$\mu\left(A, \lambda, \tilde{b}\right) = E\left[\widetilde{M}' \middle| A, \lambda, \tilde{b} \right] R_f\left(A, \lambda, \tilde{b}\right) + \eta\left(A, \lambda, \tilde{b}\right), \tag{II.7}$$

$$\mu\left(A, \lambda, \tilde{b}\right) = E\left[\widetilde{M}' \frac{\alpha\nu A' + (1-\delta_d)\, q_d\left(A', \lambda', \tilde{b}'\right)}{q_d\left(A, \lambda, \tilde{b}\right)} \middle| A, \lambda, \tilde{b} \right] + \theta(1-\delta_d)\eta\left(A, \lambda, \tilde{b}\right), \tag{II.8}$$

$$\mu\left(A, \lambda, \tilde{b}\right) = E\left[\widetilde{M}' \frac{\alpha\nu A' + (1-\delta_{nd})\, q_{nd}\left(A', \lambda', \tilde{b}'\right)}{q_{nd}\left(A, \lambda, \tilde{b}\right)} \middle| A, \lambda, \tilde{b} \right] + \theta(1-\delta_{nd})\eta\left(A, \lambda, \tilde{b}\right), \tag{II.9}$$

$$\begin{aligned} \tilde{b}'(A, \lambda, \tilde{b}) = {} & \frac{R_f(A, \lambda, \tilde{b})}{\Gamma(A, \lambda, \tilde{b}))}\,(1-\lambda)\,\tilde{b} + R_f(A, \lambda, \tilde{b})[\zeta q_d(A, \lambda, \tilde{b}) + (1-\zeta) q_{nd}(A, \lambda, \tilde{b})] \\ & - \frac{R_f(A, \lambda, \tilde{b})}{\Gamma(A, \lambda, \tilde{b})}[1-\lambda(1-\chi)](a\nu A + (1-\delta_d)\zeta q_d(A, \lambda, \tilde{b}) + (1-\delta_{nd})(1-\zeta) q_{nd}(A, \lambda, \tilde{b})), \end{aligned} \tag{II.10}$$

$$\frac{n(A, \lambda, \tilde{b}) R_f(A, \lambda, \tilde{b})}{\Gamma(A, \lambda, \tilde{b})} + \tilde{b}'(A, \lambda, \tilde{b}) = R_f(A, \lambda, \tilde{b})[\zeta q_d(A, \lambda, \tilde{b}) + (1-\zeta)\, q_{nd}(A, \lambda, \tilde{b})], \tag{II.11}$$

$$\eta\left(A, \lambda, \tilde{b}\right) \{\tilde{b}'(A, \lambda, \tilde{b}) - R_f\left(A, \lambda, \tilde{b}\right) \theta[\zeta(1-\delta_d) q_d\left(A, \lambda, \tilde{b}\right) + (1-\zeta)(1-\delta_{nd}) q_{nd}\left(A, \lambda, \tilde{b}\right)]\} = 0, \tag{II.12}$$

$$G'\left(i\left(A, \lambda, \tilde{b}\right)\right) = \phi\left(A, \lambda, \tilde{b}\right) q_d\left(A, \lambda, \tilde{b}\right) + \left(1 - \phi\left(A, \lambda, \tilde{b}\right)\right) q_{nd}\left(A, \lambda, \tilde{b}\right), \tag{II.13}$$

$$c\left(A, \lambda, \tilde{b}\right) + i\left(A, \lambda, \tilde{b}\right) + g\left(i\left(A, \lambda, \tilde{b}\right)\right) = A, \tag{II.14}$$

$$\phi\left(A, \lambda, \tilde{b}\right) = \frac{(\delta_d - \delta_{nd})\,(1-\zeta)\,\zeta}{i\left(A, \lambda, \tilde{b}\right)} + \zeta, \tag{II.15}$$

$$\Gamma\left(A, \lambda, \tilde{b}\right) = i\left(A, \lambda, \tilde{b}\right) + [1 - \zeta\delta_d - (1-\zeta)\delta_{nd}]. \tag{II.16}$$

II.3 Functional Approximation

Following Christiano and Fisher (2000), we solve the sequence of functional objects in equilibrium by using functional approximations based on Chebyshev polynomials. To implement our numerical algorithm, we use Chebyshev polynomial basis functions $T_k(x)$ up to n-orders, i.e., from order-0 to order-(n-1) $k \in \{0, 1, ..., n-1\}$, so we can approximate six equilibrium functional objects (i.e., the asset prices of durable capital $q_d(A, \lambda, \tilde{b})$) of non-durable capital $q_{nd}(A, \lambda, \tilde{b})$, the equilibrium risk-free rate $R_f(A, \lambda, \tilde{b})$, the marginal product of capital investment $\mu(A, \lambda, \tilde{b})$, the utility function $u(A, \lambda, \tilde{b})$, and the policy function on optimal consumption $c(A, \lambda, \tilde{b})$. Carrying on basis coefficients of the Chebyshev functional approximates can sufficiently help us back out the rest of the equilibrium functional objects defined in the recursive equilibrium. The six Chebyshev approximated functionals are stated as:

$$q_d(x; \lambda_i, A_j) = \sum_{k=0}^{k=n-1} d_{q_d,k,i_\lambda,j_A}(x) T_k(x) \tag{II.17}$$

$$q_{nd}(x; \lambda_i, A_j) = \sum_{k=0}^{k=n-1} d_{q_{nd},k,i_\lambda,j_A}(x) T_k(x) \tag{II.18}$$

$$R_f(x; \lambda_i, A_j) = \sum_{k=0}^{k=n-1} d_{Rf,k,i_\lambda,j_A}(x) T_k(x) \tag{II.19}$$

$$\mu(x; \lambda_i, A_j) = \sum_{k=0}^{k=n-1} d_{\mu,k,i_\lambda,j_A}(x) T_k(x) \tag{II.20}$$

$$u(x; \lambda_i, A_j) = \sum_{k=0}^{k=n-1} d_{U,k,i_\lambda,j_A}(x) T_k(x) \tag{II.21}$$

$$c(x; \lambda_i, A_j) = \sum_{k=0}^{k=n-1} d_{c,k,i_\lambda,j_A}(x) T_k(x) \tag{II.22}$$

in which x takes discrete values of $x_j = 2(\tilde{b}_j - \underline{b})/(\bar{b} - \underline{b}) - 1$ derived from the grid space of $\tilde{b}_{t-1} \in \{\tilde{b}_1, ..., \tilde{b}_{n_b}\}$. We note that such changes of variables accommodates the fact that Chebyshev polynomial basis functions $T_k(x)$ are defined over $x \in [-1, 1]$. $\bar{b}$ and $\underline{b}$ thus capture the upper and lower bounds of the predetermined redefined debt position. $A_t = A_j \in \mathbf{A}$ and $\lambda_t = \lambda_i \in \mathbf{\Lambda}$ take discrete values from some discretization on the TFP A_t and the liquidity shock process χ_t of grid points of n_A and n_χ considering their correlations. The basis coefficient vectors $d_{q_d,k,i_\lambda,j_A}(x)$, $d_{q_{nd},k,i_\lambda,j_A}(x)$, $d_{Rf,k,i_\lambda,j_A}(x)$, $d_{\mu,k,i_\lambda,j_A}(x)$, $d_{U,k,i_\lambda,j_A}(x)$, and $d_{c,k,i_\lambda,j_A}(x)$ are therefore specific to the discrete values of aggregate states.

We reach our model solution once the iterations over the basis coefficients on different orders of Chebyshev polynomials at selected nodes of state variables obtain numerical convergence. This would effectively pin down the equilibrium objects. In terms of implementation, our functional approximations are based on Chebyshev polynomial basis functions $T_k(x)$ up to 3-orders, and we confirm that our results are not sensitive to increasing the order of the Chebyshev polynomials. We also select three nodes that are the roots of the Chebyshev polynomials and effectively map them to the grids of the redefined debt positions. We set the $\bar{b} = 5$ and $\underline{b} = 0$ for reaching the model solutions. It can be shown that our model solution is robust to expanding or shrinking the width of the node grids.

II.4 Outline of the Algorithm

Finally, we outline the exact algorithm of our numerical routines to obtain the basis coefficients of Chebyshev polynomials that best approximate the equilibrium functional objects. Following Galindev and Lkhagvasuren (2010), we first generate discretized nodes of TFP shocks and the liquidity shocks of dimension $N^A \times N^\lambda = 3^2 = 9$, so we may consider their shock correlations. With $N^{\tilde{b}} = 3$ nodes of debt grids, the procedure continues in the form of iterations as below:

1. Conditional on each predetermined debt position $\tilde{b}_{t-1} = b_j$ and the realizations of A_{i_λ} and A_{j_A}, we compute the conjectured $q^0_{d,t}$, $q^0_{nd,t}$ using guess basis coefficients. Thereafter, we solve for the implied investment-capital ratio ik^1_t, the consumption-capital ratio c^1_t, and the investment share into durable capital goods ϕ^1_t, given Equations (II.13)(II.14) and (II.15).
2. Following the law of motion per Equation (II.10), conjectured $R^0_{f,t+1}$, and the computed capital growth Γ_t by Equation (II.16), we solve for the implied $\tilde{b}_t$ and the networth n_t. As a result, we can compute conjectured future consumption c^0_{t+1} and utility values u^0_{t+1} to pin down the implied risk-free rate $R^1_{f,t+1}$ and the implied utility values u^1_t. Using Equations (II.4) and (II.5), we compute the stochastic discount factors $\tilde{M}_{t+1}$ and M_{t+1}
3. We then compute the implied borrowing limit $\tilde{b}^1 = R_{f,t+1}\theta[(1-\delta_d)\zeta q^0_{d,t} + (1-\delta_{nd})(1-\zeta)q^0_{nd,t}]$, and proceed to check if the constraint is binding. If $\tilde{b}_t > \tilde{b}^1$, we set $\tilde{b}_t = b^l$ and recompute the implied expected marginal product of capital μ^1 and updated η^1_t using Equations (II.8) and (II.9). Otherwise, $\eta^1_t = 0$, and we leave the redefined debt unchanged and solve for μ^1_t per Equation (II.7)
4. Depending on updated values of μ^1_t, we solve for implied market equilibrium asset prices $q^1_{d,t}$ and $q^1_{nd,t}$ from the non-arbitrage conditions of capital investment in durable capital and non-durable capital, respectively.

5. Finally, we solve the basis coefficient vector in a linear equation system evaluated at each node of x_j at the implied values of $q^1_{d,t}, q^1_{nd,t}, R^1_{f,t+1}, \mu^1_t, u^1_t$ and c^1_t, and then update the basis coefficient vectors stacked in a long vector d in the following routine $d^* = z \cdot d^* + (1-z) \cdot d$ for which z is some dampening parameter. The program stops if $norm(d^* - d) < tol$ for which tol is some tolerance threshold.

II.5 Computational Efficiency

For a given calibration and a dimension of $6 * 3 * 9 = 162$ for all basis coefficients related to functional approximates, our model is solved fairly quickly. Running on a PC with a processor of configuration Intel(R) Core(TM) i7-1065G7 CPU @ 1.30GHz along with a 32GB RAM, it takes about 10 seconds to obtain the model solution up to a tolerance criterion of 10^{-3}.

III Proof of Proposition 1

We prove Proposition 1 in two steps: first, given prices, the quantities satisfy the household's and the entrepreneurs' optimality conditions; second, the quantities satisfy the market-clearing conditions.

Since the optimization problems of households and firms are all standard convex programming problems, we only need to verify optimality conditions. Equation (II.6) is the household's first-order condition. Equation (II.14) is a normalized version of a resource constraint (15). Both of them are satisfied as listed in Proposition 1.

To verify that the entrepreneur i's allocations $\{N_{i,t}, B_{i,t}, K^d_{i,t}, K^{nd}_{i,t}, L_{i,t}\}$ as constructed in Proposition 1 satisfy the first-order conditions for the optimization problem in equation (9), the first-order condition with respect to $B_{i,t}$ implies:

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

Similarly, the first-order condition for type-d capital $K^d_{i,t+1}$ is:

$$\mu^i_t = E_t\left[\widetilde{M}^i_{t+1} \frac{\Pi_{K^d}\left(\bar{A}_{t+1}, z_{i,t+1}, K^d_{i,t+1}, K^{nd}_{i,t+1}\right) + (1-\delta_d)\, q_{d,t+1}}{q_{d,t}}\right] + \theta(1-\delta_d)\eta^i_t. \tag{III.2}$$

Finally, the optimality with respect to the choice of type-nd capital $K^{nd}_{i,t+1}$ implies:

$$\mu^i_t = E_t\left[\widetilde{M}^i_{t+1}\frac{\Pi_{K^{nd}}\left(\bar{A}_{t+1}, z_{i,t+1}, K^d_{i,t+1}, K^{nd}_{i,t+1}\right) + (1-\delta_{nd})\, q_{nd,t+1}}{q_{d,t}}\right] + \theta(1-\delta_{nd})\eta^i_t. \quad \text{(III.3)}$$

Next, the law of motion of the endogenous state variable n can be constructed from equation (8):

$$\begin{aligned} n' &= (1-\lambda)\left[\begin{array}{c} \alpha\nu A' + \zeta\left(1-\delta_d\right) q_d\left(A', n'\right) + (1-\zeta)\left(1-\delta_{nd}\right) q_{nd}\left(A', n'\right) \\ -\theta\left[\zeta q_d\left(A, n\right) + (1-\zeta)\, q_{nd}\left(A, n\right)\right] R_f\left(A, n\right) \end{array}\right] \\ &\quad + \lambda\chi\frac{n}{\Gamma\left(A, n\right)}. \end{aligned} \quad \text{(III.4)}$$

Using the law of motion of the state variables, we can construct the normalized utility of the household as the fixed point of:

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

The stochastic discount factors must be consistent with household utility maximization:

$$\begin{aligned} M' &= \beta\left[\frac{c\left(A', n'\right)\Gamma\left(A, n\right)}{c\left(A, n\right)}\right]^{-\frac{1}{\psi}}\left[\frac{u\left(A', n'\right)}{E\left[u\left(A', n'\right)^{1-\gamma}\right]^{\frac{1}{1-\gamma}}}\right]^{\frac{1}{\psi}-\gamma}, && \text{(III.5)} \\ \widetilde{M}' &= M'[(1-\lambda)\,\mu\left(A', n'\right) + \lambda]. && \text{(III.6)} \end{aligned}$$

In our setup, we assume that the idiosyncratic shock $z_{i,t+1}$ is observed before the decisions on $K^d_{i,t+1}$ and $K^{nd}_{i,t+1}$ are made, and thus can construct an equilibrium in which μ^i_t and η^i_t are equalized across all the firms because $\frac{\partial}{\partial K^d_{i,t+1}}\Pi\left(\bar{A}_{t+1}, z_{i,t+1}, K^d_{i,t+1}, K^{nd}_{i,t+1}\right) = \frac{\partial}{\partial K^{nd}_{i,t+1}}\Pi\left(\bar{A}_{t+1}, z_{i,t+1}, K^d_{i,t+1}, K^{nd}_{i,t+1}\right)$ are the same for all i.

Our next step involves verifying the market-clearing conditions. Given the initial conditions (initial net worth N_0, $\frac{K^d_1}{K^{nd}_1} = \frac{\zeta}{1-\zeta}$, $N_{i,0} = z_{i,1}N_0$) and the net worth injection rule for new entrant firms ($N^{entrant}_{t+1} = \chi N_t$ for all t), we establish the market-clearing conditions using the following lemma. It's important to note that our model accommodates scenarios in which the collateral constraint occasionally becomes binding. The treatment of cases for which this constraint is binding or not is handled similarly.

Lemma III.1. *The optimal allocations* $\{N_{i,t}, B_{i,t}, K^d_{i,t+1}, K^{nd}_{i,t+1}\}$ *constructed as described in*

Proposition 1 satisfy the market-clearing conditions:

$$K_{t+1}^{d} = \int K_{i,t+1}^{d}\, di, \quad K_{t+1}^{nd} = \int K_{i,t+1}^{nd}\, di, \quad N_t = \int N_{i,t}\, di, \tag{III.7}$$

for all $t \geq 0$.

Before proving this lemma, we discuss the timing of the liquidation shock for a firm's entry and exit. As outlined in Section 4.1, the dynamics of the idiosyncratic shock $z_{i,t}$ follow:

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

in which $\varepsilon_{i,t+1}$ is independently and identically distributed (i.i.d) across firms and over time. Additionally, we assume that $E[e^{\varepsilon_{i,t+1}}] = e^{\mu+\frac{1}{2}\sigma^2}$ for simplicity's sake. It's important to point out that the realization of the liquidation shock λ_{t+1} and the idiosyncratic productivity shock $\varepsilon_{i,t+1}$ occur in the morning of $t+1$, before the production takes place.

After the realization of λ_{t+1} and $\varepsilon_{i,t+1}$, a fraction of $1-\lambda_{t+1}$ of firms continue to operate in the economy and use their planned $K_{i,t+1}^{d}$ and $K_{i,t+1}^{nd}$ for production. Simultaneously, a fraction of λ_{t+1} firms will liquidate and exit the economy. At the same time, an equal fraction of λ_{t+1} of new firms are born. These new firms do not generate any production at time $t+1$ but plan their $K_{i,t+2}^{d}$ and $K_{i,t+2}^{nd}$ for production at time $t+2$. The initial productivity of these new firms is denoted by $\bar{z}_{t+2}$ and is conditional on not being liquidated at time $t+2$.

The total amount of productivity z_t that is involved in production at time $t+1$ is denoted as $Z_{t+1} = \int z_{i,t} di$. The evolution of Z_{t+1} follows the following steps:

$$\begin{aligned}
Z_{t+1} &= (1-\lambda_t) \int z_{i,t+1} di + \lambda_t \bar{z}_{t+1} \\
&= (1-\lambda_t) \int z_{i,t} e^{\varepsilon_{i,t+1}} di + \lambda_t \bar{z}_{t+1} \\
&= (1-\lambda_t) \int z_{i,t} di \int e^{\varepsilon_{i,t+1}} di + \lambda_t \bar{z}_{t+1} \text{ (Independence)} \\
&= (1-\lambda_t) Z_t\, e^{\mu+\frac{1}{2}\sigma^2} + \lambda_t \bar{z}_{t+1} \text{ (Law of Large Number).}
\end{aligned}$$

We normalize the aggregation of productivity to be one in the steady-state (i.e., $Z_{t+1} = Z_t = 1$.) Therefore, the normalized initial productivity denotes:

$$\bar{z}_{t+1} = \frac{1}{\lambda_t}\Big[1 - (1-\lambda_t) e^{\mu+\frac{1}{2}\sigma^2}\Big].$$

To prove Lemma III.1, we will use induction. Let's start with the initial conditions for $t = 0$. We have $N_{i,0} = z_{i,1} N_0$, in which $z_{i,1}$ is chosen from the stationary distribution of

z. We will discuss both the binding constraint case and the non-binding constraint case separately.

If the constraint is binding for $t = 0$, then the individual entrepreneur i's capital decisions $K^d_{i,t+1}, K^{nd}_{i,t+1}$ must satisfy the following conditions:

$$N_{i,0} = [1 - \theta(1 - \delta_d)]\, q_{d,0} K^d_{i,1} + [1 - \theta(1 - \delta_{nd})]\, q_{nd,0} K^{nd}_{i,1}, \tag{III.8}$$

$$K^d_{i,1} + K^{nd}_{i,1} = z_{i,1}(K^d_1 + K^{nd}_1). \tag{III.9}$$

Clearly, we solve $K^d_{i,1}$ and $K^{nd}_{i,1}$ according to the above two equations, in which the solutions for $K^d_{i,1}$ and $K^{nd}_{i,1}$ denote $K^d_{i,1} = z_{i,1}K^d_1$ and $K^{nd}_{i,1} = z_{i,1}K^{nd}_1$. In turn, $B_{i,0} = z_{i,1}B_0$.

Suppose that the constraint is not binding for $t = 0$. The aggregate borrowing constraint can be expressed as:

$$B_0 \leq \theta(1 - \delta_d) q_{d,1} K^d_1 + \theta(1 - \delta_{nd}) q_{nd,1} K^{nd}_1, \tag{III.10}$$

in which the inequality ensures that the aggregate borrowing does not exceed the fraction of capital investment that can be financed through external borrowing in the first period.

To initiate the recursion process, we assume that the same allocation rule is applied as in the case when the constraint is binding (i.e., $K^d_{i,1}$ and $K^{nd}_{i,1}$.) This allows us to demonstrate that $B_{i,0} = z_{i,1}B_0$ and that the borrowing constraint remains non-binding at the firm level.

Given that $Z_1 = \int z_{i,t} di = 1$, the following conditions hold at the end of period 0:

$$\int K^d_{i,1}\, di = K^d_1, \quad \int K^{nd}_{i,1}\, di = K^{nd}_1, \quad \int N_{i,0}\, di = N_0. \tag{III.11}$$

At the beginning of period 1, the realization of λ_1 occurs. A fraction of $1 - \lambda_1$ of firms continue to exist in the economy for production, utilizing the planned $K^d_{i,1}$ and $K^{nd}_{i,1}$. After production and repayment of their debt, firm i's net worth is given by:

$$N_{i,1} = \alpha A_1 (K^d_{i,1} + K^{nd}_{i,1}) + (1 - \delta_d) q_{d,1} K^d_{i,1} + (1 - \delta_{nd}) q_{nd,1} K^{nd}_{i,1} - R_{f,1} B_{i,0}. \tag{III.12}$$

On the other hand, a fraction of λ_1 firms are liquidated and re-enter the economy with an initial net worth of $N^{entrant}_1$, which is given by:

$$N^{entrant}_1 = \chi \left[\alpha A_1 (K^d_{i,1} + K^{nd}_{i,1}) + (1 - \delta_d) q_{d,1} K^d_{i,1} + (1 - \delta_{nd}) q_{nd,1} K^{nd}_{i,1}\right]. \tag{III.13}$$

These newly born firms do not engage in production during period 1. Instead, they wait for the realization of $z_{i,2}$ and plan their capital allocations $K^d_{i,2}$ and $K^{nd}_{i,2}$ for the next period.

To track the aggregation, we consider the total net worth of both existing firms and newly born firms (i.e., new entrants) at $t = 1$:

$$\begin{aligned}(1-\lambda_1)\int N_{i,1}di + \lambda_1 N_1^{entrant} &= (1-\lambda_1)\int \Big[\alpha A_1(K_{i,1}^d + K_{i,1}^n) + (1-\delta_d)q_{d,1}K_{i,1}^d \\ &\quad +(1-\delta_{nd})q_{nd,1}K_{i,1}^{nd} - R_{f,1}B_{i,0}\Big]di \\ &\quad +\lambda_1\chi\Big[\alpha A_1(K_{i,1}^d + K_{i,1}^n) + (1-\delta_d)q_{d,1}K_{i,1}^d + (1-\delta_{nd})q_{nd,1}K_{i,1}^{nd}\Big].\end{aligned}$$

At the end of period 1, each firm, including existing firms and new entrants, will observe $z_{i,2}$ and plan $K_{i,2}^d$ and $K_{i,2}^{nd}$ for period 2 accordingly. After realizing the liquidation shock at $t = 2$, firms generate production without liquidation. Similarly, the productivity of exiting firms is denoted as $z_{i,2} = z_{i,1}\, e^{\varepsilon_{i,2}}$, while the productivity of newly born exiting firms is denoted as $\bar{z}_2$, which is given by $\bar{z}_2 = \frac{1}{\lambda_1}\Big[1-(1-\lambda_1)e^{\mu+\frac{1}{2}\sigma^2}\Big]$. The total productivity at $t = 2$ is calculated as follows:

$$\begin{aligned}Z_2 &= (1-\lambda_1)\int z_{i,2}di + \lambda_1\bar{z}_2 \\ &= (1-\lambda_1)\int z_{i,1}e^{\varepsilon_{i,2}}di + \lambda_1\bar{z}_2 \\ &= (1-\lambda_1)\int z_{i,1}di\int e^{\varepsilon_{i,2}}di + \lambda_1\bar{z}_2 \text{ (Independence)} \\ &= (1-\lambda_t)Z_1\, e^{\mu+\frac{1}{2}\sigma^2} + \lambda_1\bar{z}_2 \text{ (Law of Large Number)}.\end{aligned}$$

Next, firm i decides the allocation between durable and non-durable capital for production. We note that when a firm's financial constraint is not binding, the specific capital allocation among firms for different capital types is not uniquely determined, given the perfect substitutability of two capital types. A firm, therefore, has different paths of capital financing over time. Concerning this indeterminacy issue, in the following, we present a way to determine $K_{i,2}^d$ and $K_{i,2}^{nd}$ separately by constructing a modified version of equation (III.8). Recalling the non-binding case, the borrowing constraint at the aggregate level is denoted as:

$$B_1 \leq \theta(1-\delta_d)q_{d,1}K_2^d + \theta(1-\delta_{nd})q_{nd,1}K_2^{nd}. \tag{III.14}$$

We take the aggregate measure of constraint slackness in period 1, $\Delta_1 \geq 0$, according to equation (40). It follows that:

$$B_1 = (\theta-\Delta_1)\Big[(1-\delta_d)q_{d,1}K_2^d + (1-\delta_{nd})q_{nd,1}K_2^{nd}\Big], \tag{III.15}$$

and

$$\Delta_1 = \theta - \frac{B_1}{(1-\delta_d)q_{d,1}K_2^d + (1-\delta_{nd})q_{nd,1}K_2^{nd}}. \tag{III.16}$$

Δ_1 equals 0 when the collateral constraint is binding, under which the capital allocation will be uniquely determined at the firm level. By allowing for $\Delta_1 \geq 0$, our capital allocation scheme for the first period is close enough to that of the determinacy case when the aggregate constraint is binding as $\Delta_1 \to 0$. We, therefore, regard our firm-level capital allocation as one of the many possible distributional realizations consistent with the equilibrium at the aggregate level.

We further assume that the borrowing constraint in equation (III.14) holds at the firm level:

$$B_{i,1} = (\theta - \Delta_1)\Big[(1-\delta_d)q_{d,1}K_{i,2}^d + (1-\delta_{nd})q_{nd,1}K_{i,2}^{nd}\Big]. \tag{III.17}$$

Combining the system in equation (III.8) with equation (III.17), we can solve for $K_{i,2}^d$ and $K_{i,2}^{nd}$ simultaneously:

$$\begin{aligned} N_{i,1} &= [1-(\theta-\Delta_1)(1-\delta_d)]\, q_{d,1}K_{i,2}^d + [1-(\theta-\Delta_1)(1-\delta_{nd})]\, q_{nd,1}K_{i,2}^{nd}, \\ K_{i,1}^d + K_{i,1}^{nd} &= z_{i,1}(K_1^d + K_1^{nd}). \end{aligned}$$

The solution for $K_{i,2}^d$ and $K_{i,2}^{nd}$ is given by:

$$\begin{aligned} K_{i,2}^d &= \frac{N_{i,1} - z_{i,2}\,[1-(\theta-\Delta_1)(1-\delta_{nd})]\, q_{nd,1}(K_2^d + K_2^{nd})}{[1-(\theta-\Delta_1)(1-\delta_d)]\, q_{d,1} - [1-(\theta-\Delta_1)(1-\delta_{nd})]\, q_{nd,1}}, \\ K_{i,2}^{nd} &= z_{i,2}(K_2^d + K_2^{nd}) - K_{i,2}^d. \end{aligned}$$

According to the above solution, durable and non-durable capital and net worth among existing firms are no longer proportional to $z_{i,2}$. However, given that $\int N_{i,1}di = N_1$ and $\int z_{i,2}di = 1$, we integrate the solution across i and obtain the result:

$$\begin{aligned} \left\{ \begin{array}{c} [1-(\theta-\Delta_1)(1-\delta_d)]\, q_{d,1}\int K_{i,2}^d di \\ +[1-(\theta-\Delta_1)(1-\delta_{nd})]\, q_{nd,1}\int K_{i,2}^{nd} di \end{array} \right\} &= \int N_{i,1}di = N_1, \\ \int K_{i,2}^d di + \int K_{i,2}^{nd} di &= \int z_{i,2}di\,\left(K_2^d + K_2^{nd}\right) = K_2^d + K_2^{nd}. \end{aligned}$$

It is not necessary to complete the induction argument. If the market-clearing condition holds for $t+1$, then it must hold for $t+2$ and for all rest periods. The following claim characterizes this property:

Claim 1. *Suppose* $\int K^d_{i,t+1}\,di = K^d_{t+1}$, $\int K^{nd}_{i,t+1}\,di = K^{nd}_{t+1}$, $\int N_{i,t}\,di = N_t$, *and*

$$N^{entrant}_{t+1} = \chi\Big[\alpha A_{t+1}(K^d_{i,t+1} + K^n_{i,t+1}) + (1-\delta_d)q_{d,t+1}K^d_{i,t+1} + (1-\delta_{nd})q_{nd,t+1}K^{nd}_{i,t+1}\Big] \quad \text{(III.18)}$$

then

$$\int K^d_{i,t+2}\,di = K^d_{t+2}, \quad \int K^{nd}_{i,t+2}\,di = K^{nd}_{t+2}, \quad \int N_{i,t+1}\,di = N_{t+1} \quad \text{(III.19)}$$

for all $t \geq 0$.

1. Using the law of motion for the net worth of existing firms, we can rewrite the total net worth of all surviving firms as follows:

$$\begin{aligned}
&(1-\lambda_{t+1})\int N_{i,t+1}\,di \\
= \;& (1-\lambda_{t+1})\int \left[\begin{array}{c} \alpha A_{t+1}\left(K^d_{i,t+1} + K^{nd}_{i,t+1}\right) + (1-\delta_d)\,q_{d,t+1}K^d_{i,t+1} \\ + (1-\delta_{nd})\,q_{nd,t+1}K^{nd}_{i,t+1} - R_{f,t+1}B_{i,t} \end{array}\right] di \\
= \;& (1-\lambda_{t+1})\left[\alpha A_{t+1}\left(K^d_{t+1} + K^{nd}_{t+1}\right) + (1-\delta_d)\,q_{d,t}K^d_{t+1} + (1-\delta_{nd})\,q_{nd,t}K^{nd}_{t+1} - R_{f,t+1}B_t\right].
\end{aligned}$$

   Following the assumption $\int K^d_{i,t+1}di = K^d_{t+1}$, $\int K^{nd}_{i,t+1}di = K^{nd}_{t+1}$, and $\int B_{i,t}di = B_t = (\theta - \Delta_t)\left[(1-\delta_d)q_{d,t}K^d_{t+1} + (1-\delta_{nd})q_{nd,t}K^{nd}_{t+1}\right]$, and using the assignment rule for the net worth of new entrants $N^{entrant}_{t+1}$ in equation (III.18), we can demonstrate that the total net worth at the end of period $t+1$ across both survivors and new entrants satisfies $\int N_{i,t+1}di = N_{t+1}$, in which the aggregate net worth N_{t+1} is given by equation (8).
2. At the end of period $t+1$, we have a pool of firms consisting of both existing ones with net worth given by equation (7) and new entrants. All of these firms will observe $z_{i,t+2}$ (for the new entrants $z_{i,t+2} = \bar{z}_{t+2}$) and begin production at the beginning of period $t+1$.
   We compute capital holdings for period $t+2$ for each firm i using equations (3) and (20). At this point in time, capital holdings and net worth of all existing firms will not necessarily be proportional to $z_{i,t+2}$ due to the heterogeneity in the realization of idiosyncratic productivity shocks. However, we know that $\int N_{i,t+1}di = N_{t+1}$ and $\int z_{i,t+2}di = 1$. Similar to the case for period $t+1$, we integrate equations (3) and (20) across all i and obtain the following two equations:

$$\begin{aligned}
N_{t+1} \;=\;& \left[1-(\theta-\Delta_{t+1})(1-\delta_d)\right]q_{d,t+1}\int K^d_{i,t+2}\,di \qquad \text{(III.20)} \\
& + \left[1-(\theta-\Delta_{t+1})(1-\delta_{nd})\right]q_{nd,t+1}\int K^{nd}_{i,t+2}\,di,
\end{aligned}$$

$$K_{t+2}^{d}+K_{t+2}^{nd}=\int K_{i,t+2}^{d}\,di+\int K_{i,t+2}^{nd}\,di, \tag{III.21}$$

in which we have used $\int N_{i,t+1}\,di = N_{t+1}$ and $\int z_{i,t+2}\,di = 1$. In turn, this implies $\int K_{i,t+2}^{d}\,di = K_{t+2}^{d}$ and $\int K_{i,t+2}^{nd}\,di = K_{t+2}^{nd}$. Hence, the claim is proven.

In summary, we have demonstrated that equilibrium prices and quantities outlined in Proposition 1 adhere to optimality conditions of households and entrepreneurs, and that the quantities also satisfy market-clearing conditions.

Finally, we present a recursive relationship that can be utilized to solve for $\Theta(A,n)$ based on the equilibrium derived in Proposition 1. The recursion (9) implies:

$$\begin{aligned}
\mu_t N_{i,t}+\Theta_t z_{i,t+1}(K_t^d+K_t^{nd}) &= E_t\big[M_{t+1}(1-\lambda_{t+1})\big(\mu_{t+1}N_{i,t+1}+\Theta_{t+1}(K_{t+1}^d+K_{t+1}^{nd})z_{i,t+2}\big)+\lambda_{t+1}N_{i,t+1}\big]\\
&= E_t\big[M_{t+1}\{(1-\lambda_{t+1})\mu_{t+1}+\lambda_{t+1}\}N_{i,t+1}\big]\\
&\quad +(1-\lambda_{t+1})z_{i,t+1}E_t\big[M_{t+1}\Theta_{t+1}(K_{t+1}^d+K_{t+1}^{nd})\big]\\
&= E_t\big[\widetilde{M}_{t+1}N_{i,t+1}\big]+(1-\lambda_{t+1})z_{i,t+1}E_t\big[M_{t+1}\Theta_{t+1}(K_{t+1}^d+K_{t+1}^{nd})\big].
\end{aligned}$$

We next begin by simplifying the term $E_t\left[\widetilde{M}_{t+1}N_{i,t+1}\right]$. We note that an intermittently binding collateral constraint, combined with the entrepreneur's budget constraint (3), leads to the following condition:

$$\left[1-(\theta-\Delta_t)(1-\delta_d)\right]q_{d,t}K_{i,t+1}^d+\left[1-(\theta-\Delta_t)(1-\delta_{nd})\right]q_{nd,t}K_{i,t+1}^{nd}=N_{i,t}. \tag{III.22}$$

Equation (III.22), along with the optimality condition (20), determines the functions of $K_{i,t+1}^d$ and $K_{i,t+1}^{nd}$ in terms of $N_{i,t}$ and $z_{i,t+1}$:

$$K_{i,t+1}^d = \frac{N_{i,t}-z_{i,t+1}\left[1-(\theta-\Delta_t)(1-\delta_{nd})\right]q_{nd,t}(K_{t+1}^d+K_{t+1}^{nd})}{\left[1-(\theta-\Delta_t)(1-\delta_d)\right]q_{d,t}-\left[1-(\theta-\Delta_t)(1-\delta_{nd})\right]q_{nd,t}}, \tag{III.23}$$

$$K_{i,t+1}^{nd} = \frac{z_{i,t+1}\left[1-(\theta-\Delta_t)(1-\delta_d)\right]q_{d,t}(K_{t+1}^d+K_{t+1}^{nd})-N_{i,t}}{\left[1-(\theta-\Delta_t)(1-\delta_d)\right]q_{d,t}-\left[1-(\theta-\Delta_t)(1-\delta_{nd})\right]q_{nd,t}}. \tag{III.24}$$

Utilizing the outcomes from equation (III.23) and the firm i's net worth law of motion in equation (7), we can express $N_{i,t+1}$ as a linear function of $N_{i,t}$ and $z_{i,t+1}$:

$$
\begin{aligned}
N_{i,t+1} \;=\;& z_{i,t+1}\alpha A_{t+1}\left(K^{d}_{t+1}+K^{nd}_{t+1}\right)\\
&+(1-\delta_d)\,q_{d,t+1}\frac{N_{i,t}-z_{i,t+1}\left[1-(\theta-\Delta_t)(1-\delta_{nd})\right]q_{nd,t}(K^{d}_{t+1}+K^{nd}_{t+1})}{\left[1-(\theta-\Delta_t)(1-\delta_d)\right]q_{d,t}-\left[1-(\theta-\Delta_t)(1-\delta_{nd})\right]q_{nd,t}}\\
&+(1-\delta_{nd})\,q_{nd,t+1}\frac{z_{i,t+1}\left[1-(\theta-\Delta_t)(1-\delta_d)\right]q_{d,t}(K^{d}_{t+1}+K^{nd}_{t+1})-N_{i,t}}{\left[1-(\theta-\Delta_t)(1-\delta_d)\right]q_{d,t}-\left[1-(\theta-\Delta_t)(1-\delta_{nd})\right]q_{nd,t}}\\
&-R_{f,t+1}(\theta-\Delta_t)\,(1-\delta_d)\,q_{d,t}\frac{N_{i,t}-z_{i,t+1}\left[1-(\theta-\Delta_t)(1-\delta_{nd})\right]q_{nd,t}(K^{d}_{t+1}+K^{nd}_{t+1})}{\left[1-(\theta-\Delta_t)(1-\delta_d)\right]q_{d,t}-\left[1-(\theta-\Delta_t)(1-\delta_{nd})\right]q_{nd,t}}\\
&-R_{f,t+1}(\theta-\Delta_t)\,(1-\delta_{nd})\,q_{nd,t}\frac{z_{i,t+1}\left[1-(\theta-\Delta_t)(1-\delta_d)\right]q_{d,t}(K^{d}_{t+1}+K^{nd}_{t+1})-N_{i,t}}{\left[1-(\theta-\Delta_t)(1-\delta_d)\right]q_{d,t}-\left[1-(\theta-\Delta_t)(1-\delta_{nd})\right]q_{nd,t}}.
\end{aligned}
$$

We are specifically concerned with the coefficients related to $z_{i,t+1}$. Collecting the terms that incorporate $z_{i,t+1}$ on both sides of equation (III.22), we obtain:

$$\Theta_t z_{i,t+1}\left(K^{d}_{t+1}+K^{nd}_{t+1}\right)=z_{i,t+1}\left(K^{d}_{t+1}+K^{nd}_{t+1}\right)\times Term,$$

in which

$$
\begin{aligned}
Term \;=\;& E_t\left[\widetilde{M}_{t+1}\left\{\begin{array}{c}
\alpha A_{t+1}\\
+(1-\delta_d)q_{d,t+1}\left(\frac{-[1-(\theta-\Delta_t)(1-\delta_{nd})]q_{nd,t}}{[1-(\theta-\Delta_t)(1-\delta_d)]q_{d,t}-[1-(\theta-\Delta_t)(1-\delta_{nd})]q_{nd,t}}\right)\\
+(1-\delta_{nd})q_{nd,t+1}\left(\frac{[1-(\theta-\Delta_t)(1-\delta_d)]q_{d,t}}{[1-(\theta-\Delta_t)(1-\delta_d)]q_{d,t}-[1-(\theta-\Delta_t)(1-\delta_{nd})]q_{nd,t}}\right)\\
-R_{f,t}\theta q_{d,t}\left(\frac{-[1-(\theta-\Delta_t)(1-\delta_{nd})]q_{nd,t}}{[1-(\theta-\Delta_t)(1-\delta_d)]q_{d,t}-[1-(\theta-\Delta_t)(1-\delta_{nd})]q_{nd,t}}\right)\\
-R_{f,t}\theta q_{nd,t}\left(\frac{[1-(\theta-\Delta_t)(1-\delta_d)]q_{d,t}}{[1-(\theta-\Delta_t)(1-\delta_d)]q_{d,t}-[1-(\theta-\Delta_t)(1-\delta_{nd})]q_{nd,t}}\right)
\end{array}\right\}\right]\\
&+(1-\lambda)\,E_t\left[M_{t+1}\Theta_{t+1}\right].
\end{aligned}
$$

We can simplify the first term by utilizing the first-order conditions (II.7)-(II.9), which results in:

$$E_t\left[\widetilde{M}_{t+1}\left\{\alpha\left(1-\nu\right)A_{t+1}\right\}\right].$$

Therefore, we arrive at the following recursive relationship for $\Theta\left(A,n\right)$:

$$
\begin{aligned}
\Theta\left(A,n\right) \;=\;& \left[1-\delta+i\left(A,n\right)\right]\Big\{\alpha\left(1-\nu\right)E\left[M'\left\{\lambda+(1-\lambda)\,\mu\left(A',n'\right)\right\}A'\right] \\
&+(1-\lambda)\,E\left[M'\Theta\left(A',n'\right)\right]\Big\}.
\end{aligned}
\qquad \text{(III.25)}
$$

The term $\alpha(1-\nu)A'$ represents the firm's profit due to decreasing returns to scale. It's clear that $\Theta(A,n)$ can be interpreted as the present value of profit. In the scenario of constant returns to scale, $\Theta(A,n)=0$.

IV Data Construction

This section outlines how we (i) form our samples of firms for our empirical analysis and (ii) create firm characteristics to account for underlying fundamentals.

IV.1 Asset Prices and Accounting Data

Our dataset comprises firms that are common to both Compustat and CRSP (Center for Research in Security Prices). Accounting data are sourced from Compustat, while stock return data are gathered from CRSP. Our chosen firms meet the following criteria: they consist of positive durability data, there are no missing SIC codes, and their domestic common shares (SHRCD = 10 and 11) are traded on NYSE, AMEX, and NASDAQ. We exclude utility firms with four-digit SIC codes between 4900 and 4999, finance firms with SIC codes between 6000 and 6999 (encompassing finance, insurance, trusts, and real estate sectors), as well as public administrative firms with SIC codes between 9000 and 9999. Following Campello and Giambona (2013), we omit firm-year observations with total assets or sales values under $1 million. Additionally, we follow Fama and French (1993) and exclude closed-end funds, trusts, American Depository Receipts, Real Estate Investment Trusts, and units of beneficial interest. To counteract backfilling bias, we require that firms be listed on Compustat for at least two years before being included in our sample. Macroeconomic data are sourced from the Federal Reserve Economic Data (FRED) maintained by the Federal Reserve in St. Louis.

V Additional Empirical Evidence

In this section, we present supplementary empirical findings regarding the connection between asset durability and various other firm characteristics. Additionally, we present a summary of the statistics for asset durability across different industries.

V.1 More Detailed Firm Characteristics

Table IA.3 provides an overview of the relationship between variations in asset durability among firms and various other firm characteristics. The table presents the average asset durability and corresponding characteristics across five portfolios, which are sorted based on firm-level asset durability, specifically among financially constrained firms.

[Place Table IA.3 about here]

In our sample, we have a total of 1,821 firms. These firms are divided into five portfolios based on asset durability, with each portfolio representing a quintile ranging from the lowest to the highest durability. The distribution of firms across these portfolios is relatively even, with the number of firms in each portfolio ranging from 301 to 417 on average.

Asset durability varies significantly across these portfolios, spanning a range from 7.69 to 18.00. Interestingly, the size of firms does not exhibit substantial variation, although it does follow a hump-shaped pattern across the durability portfolios.

Examining other firm characteristics, we observe that firms with lower asset durability tend to have lower book-to-market ratios (B/M) and higher investment rates (I/K) and Tobin's q, indicating a higher potential for investment opportunities. Additionally, firms with lower durability exhibit lower profitability as measured by the return on assets (ROA), along with lower borrowing capacity as measured by book leverage. These firms also appear to be more financially constrained, as evidenced by their lower values of SA and WW indices. These characteristics collectively suggest that firms facing financial constraints, those with limited tangibility and promising investment prospects, tend to opt for less durable assets.

Finally, we note a negative association between asset durability and collateralizability, implying that firms with higher asset durability may have more collateralizable assets compared to those with lower durability, which aligns with our model in equation (4).

V.2 Summary Statistics across Industries

Table IA.4 presents the average values of asset durability and depreciation by considering tangible and intangible assets separately across various industries based on BEA industry classifications.

Clearly, asset durability and depreciation vary significantly across industries. For instance, industries like educational services and accommodations tend to have higher asset durability and lower depreciation, while other industries might exhibit the opposite pattern. The observed cross-industry variations in asset durability and depreciation are substantial, spanning from 10.84 to 49.49.

These findings highlight the importance of considering industry effects when analyzing the relationship between asset durability and other variables. By controlling for industry fixed effects, we ensure that our results are not influenced by idiosyncratic characteristics of any particular industry but rather capture the broader relationships between asset durability and various characteristics across firms within each industry.

[**Place Table IA.4 about here**]

Table IA.1: Asset Pricing Factor Tests

This table presents asset pricing factor tests for five portfolios sorted on emissions scaled by total assets relative to their industry peers, utilizing NAICS 3-digit industry classifications and rebalancing portfolios at the end of every June. Our results are based on monthly data, spanning from July 1978 to December 2017, and exclude utility, financial, and public administrative industries. The entire sample is divided into financially constrained and unconstrained firms, as classified by the dividend payment dummy (DIV). To account for risk exposure, we conduct time-series regressions of asset-durability-sorted portfolios' excess returns on the Fama-French five-factor model plus the collateralizability factor, which encompasses MKT, SMB, HML, RMW, CMA, LMH, and COL in Panel A. In Panel B, we report portfolio alphas and betas are reported by the HXZ q-factor model plus the collateralizability factor, which includes MKT, SMB, I/A, ROE, and COL. Data sources for the factors are specified accordingly. Betas and alphas are annualized by multiplying by 12. We estimate standard errors using the Newey-West correction, and corresponding t-statistics are reported in parentheses.

	L	**2**	**3**	**4**	**H**	**H-L**
			Panel A: FF5 + COL			
$\alpha_{\text{FF5+COL}}$	-4.13	2.51	1.55	0.43	4.02	8.14
[t]	-2.06	1.44	0.94	0.29	2.52	3.38
MKT	1.28	1.14	1.15	1.13	1.17	-0.11
[t]	24.57	32.69	29.01	36.65	33.10	-2.22
SMB	0.51	0.46	0.36	0.46	0.43	-0.08
[t]	5.97	6.35	6.22	8.25	7.54	-0.91
HML	-0.24	-0.35	-0.33	-0.46	-0.38	-0.15
[t]	-2.45	-4.77	-4.35	-6.83	-4.92	-1.69
RMW	-0.10	-0.24	-0.11	0.02	-0.06	0.04
[t]	-0.78	-2.19	-1.53	0.34	-0.78	0.25
CMA	-0.44	-0.42	-0.51	-0.31	-0.25	0.19
[t]	-3.21	-4.18	-4.58	-3.27	-2.88	1.47
COL	0.10	0.13	0.13	0.09	0.03	-0.07
[t]	2.67	3.50	3.69	2.88	0.83	-1.67
			Panel B: HXZ + COL			
$\alpha_{\text{HXZ+COL}}$	-4.71	1.65	1.60	-0.30	3.82	8.54
[t]	-2.36	0.86	0.79	-0.17	2.26	3.48
MKT	1.31	1.18	1.17	1.15	1.18	-0.13
[t]	19.40	28.08	26.40	28.47	30.62	-2.20
SMB	0.42	0.37	0.26	0.37	0.37	-0.06
[t]	3.30	3.96	4.37	5.74	7.01	-0.42
I/A	-0.62	-0.77	-0.88	-0.80	-0.69	-0.08
[t]	-5.18	-8.05	-9.03	-9.30	-8.59	-0.64
ROE	-0.03	-0.08	-0.04	0.12	0.01	0.04
[t]	-0.34	-0.98	-0.55	1.92	0.17	0.62
COL	0.17	0.24	0.21	0.18	0.11	-0.06
[t]	3.36	6.21	6.36	6.13	3.83	-1.15

Table IA.2: Fama-Macbeth Regressions

This table presents the results of Fama-MacBeth regressions, in which we analyze individual stock excess returns based on their asset durability and alternative variables that are relevant in the literature. We conduct our regressions in a cross-sectional manner for each month, spanning from July of year t to June of year $t+1$. Specifically, in each month, we regress the monthly excess returns of individual stocks (annualized by multiplying by 12) on the asset durability value from year $t-1$, various sets of control variables known by the end of June of year t, and industry fixed effects. Industry categories are defined using NAIC 3-digit industry classifications. To mitigate the influence of outliers, all independent variables are normalized to have a zero mean and one standard deviation, after winsorization at the 1st and 99th percentiles. Our reported t-statistics are computed based on standard errors that we estimated using the Newey-West correction. The sample period for the analysis spans from July 1978 to December 2017.

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Durability	2.13	3.62	2.76	1.74	2.31	2.09	1.56	1.95	1.84	1.29	1.46	1.93
[t]	3.44	5.24	4.28	2.35	3.23	3.37	2.74	3.10	3.08	2.13	2.86	3.14
Colllateralizability		-3.07										
[t]		-3.87										
Operating Lev.			1.46									2.18
[t]			2.86									3.79
Log Inflex				-0.51								0.98
[t]				-1.25								2.60
Redeployability					-0.49							0.31
[t]					-0.66							0.37
Durable Output						-5.01						-5.88
[t]						-3.10						-2.85
O							-2.71					0.49
[t]							-2.79					0.42
Z								-2.07				0.22
[t]								-1.46				0.19
DD									-1.59			-1.87
[t]									-1.51			-1.47
FP										-17.55		-18.49
[t]										-1.37		-3.85
Log ME											-0.75	0.36
[t]											-0.67	0.29
Log B/M											4.82	4.77
[t]											8.73	5.66
ROA											6.36	6.91
[t]											8.98	6.72
I/K											-1.13	-1.62
[t]											-2.78	-2.37
OC/AT											1.03	1.66
[t]											2.29	2.42
R&D/AT											5.71	6.11
[t]											7.05	6.97
Book Lev.	-1.89	-0.57	-2.02	-1.66	-1.55	-1.85	-0.75	-2.57	-1.71	-1.40	-0.99	-0.32
[t]	-4.17	-1.09	-4.48	-3.33	-2.94	-4.11	-1.32	-5.52	-3.62	-2.99	-2.28	-0.43
Observations	846,277	632,464	778,893	725,608	737,897	846,277	819,508	841,335	608,519	750,884	806,449	476,878
R-squared	0.09	0.10	0.09	0.11	0.09	0.09	0.09	0.09	0.10	0.09	0.11	0.14
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table IA.3: Firm Characteristics

This table presents time-series averages of the cross-sectional median values of firm characteristics across five portfolios. These portfolios are sorted based on asset durability relative to their industry peers, and industry classifications are based on NAICS 3-digit codes. The portfolios are rebalanced at the end of every June. The sample used for this analysis covers the years from 1977 to 2016, and it excludes industries in the financial, utility, and public administrative sectors. To differentiate between financially constrained and unconstrained firms, we classify the entire sample into these two categories at the end of each June. This classification is based on the dividend payment dummy as indicated by the dividend payment dummy (DIV), following the approach outlined in Farre-Mensa and Ljungqvist (2016). We report the results for the five portfolios that are part of the financially constrained subsample. For a detailed understanding of the variables and their definitions, please refer to Table IA.5 in the Internet Appendix.

Variables	**L**	**2**	**3**	**4**	**H**
Asset Durability	7.69	9.99	11.45	14.24	18.00
Depreciation	0.19	0.16	0.15	0.13	0.11
Log ME	4.88	5.13	5.16	5.22	5.07
B/M	0.48	0.51	0.53	0.60	0.67
I/K	0.37	0.30	0.28	0.24	0.22
q	1.65	1.54	1.48	1.37	1.27
ROA	0.07	0.09	0.10	0.11	0.11
ROE	0.12	0.17	0.18	0.22	0.23
OC/AT	0.36	0.25	0.21	0.17	0.13
R&D/AT	0.03	0.03	0.03	0.00	0.00
Collateralizability	0.21	0.25	0.27	0.37	0.51
Book Lev.	0.13	0.19	0.21	0.28	0.32
Short-term Lev.	0.02	0.02	0.02	0.03	0.03
Long-term Lev.	0.04	0.09	0.11	0.17	0.21
TANT	0.08	0.13	0.17	0.25	0.34
SA	-2.47	-2.68	-2.80	-2.91	-2.92
WW	-0.16	-0.18	-0.19	-0.20	-0.20
Number of Firms	365	345	301	393	417

Table IA.4: Asset Durability and Depreciation across BEA Industries

This table provides summary statistics for the average asset durability and depreciation associated with tangible and intangible assets across various industries. The industries are categorized according to the BEA industry classifications. The data cover the period from 1977 to 2016.

BEA Industries	**Tangible**		**Intangible**	
Industry Name	**Durability**	**Depreciation**	**Durability**	**Depreciation**
Farms	27.92	0.07	2.58	0.40
Forestry, fishing, and related activities	24.43	0.09	2.38	0.43
Oil and gas extraction	14.98	0.07	4.33	0.23
Mining, except oil and gas	20.56	0.07	4.50	0.23
Support activities for mining	13.67	0.09	3.40	0.30
Utilities	40.49	0.03	3.38	0.31
Construction	20.13	0.10	3.95	0.26
Wood products	22.67	0.07	4.61	0.23
Nonmetallic mineral products	20.65	0.07	5.90	0.17
Primary metals	21.28	0.07	5.73	0.17
Fabricated metal products	19.36	0.08	5.68	0.18
Machinery	20.94	0.07	5.68	0.18
Computer and electronic products	22.97	0.07	3.44	0.29
Electrical equipment, appliances, and components	23.98	0.06	5.89	0.17
Motor vehicles, bodies and trailers, and parts	17.97	0.08	3.19	0.31
Other transportation equipment	24.09	0.06	4.47	0.22
Furniture and related products	23.05	0.06	5.37	0.19
Miscellaneous manufacturing	22.33	0.07	5.86	0.17
Food, beverage, and tobacco products	21.90	0.07	5.55	0.18
Textile mills and textile product mills	22.65	0.06	5.46	0.18
Apparel and leather and allied products	26.52	0.06	5.73	0.17
Paper products	18.12	0.08	5.38	0.19
Printing and related support activities	19.06	0.08	5.02	0.21
Petroleum and coal products	21.09	0.07	5.86	0.17
Chemical products	22.25	0.07	8.09	0.12
Plastics and rubber products	18.44	0.08	5.72	0.18
Wholesale trade	24.93	0.08	4.13	0.25
Retail trade	33.63	0.05	4.05	0.26
Air transportation	19.23	0.07	3.28	0.31
Railroad transportation	44.31	0.03	4.30	0.25
Water transportation	18.99	0.06	4.08	0.26
Truck transportation	11.49	0.14	4.19	0.26
Transit and ground passenger transportation	35.17	0.05	3.50	0.30
Pipeline transportation	39.5	0.03	3.12	0.32
Other transportation and support activities	30.07	0.06	3.50	0.31
Warehousing and storage	37.45	0.04	3.88	0.28
Publishing industries (including software)	23.51	0.07	6.39	0.16
Motion picture and sound recording industries	29.43	0.05	7.86	0.13
Broadcasting and telecommunications	34.89	0.04	5.42	0.19
Information and data processing services	22.86	0.10	4.50	0.23
Federal Reserve banks	34.66	0.05	3.25	0.31
Credit intermediation and related activities	26.75	0.07	2.99	0.34
Securities, commodity contracts, and investments	35.37	0.04	3.12	0.32
Insurance carriers and related activities	33.83	0.05	3.10	0.33
Funds, trusts, and other financial vehicles	40.54	0.03	3.02	0.33
Real estate	40.04	0.03	2.89	0.35
Rental and leasing services and lessors of intangible assets	10.84	0.12	2.87	0.35
Legal services	31.14	0.06	2.57	0.40
Computer systems design and related services	31.76	0.07	2.83	0.35
Miscellaneous professional, scientific, and technical services	26.62	0.07	5.41	0.19
Management of companies and enterprises	35.71	0.04	3.23	0.31
Administrative and support services	29.09	0.07	2.79	0.36
Waste management and remediation services	48.14	0.05	3.91	0.26
Educational services	49.49	0.03	4.80	0.21
Ambulatory health care services	34.39	0.06	4.86	0.21
Hospitals	45.77	0.04	4.39	0.24
Nursing and residential care facilities	39.67	0.04	5.05	0.20
Social assistance	37.26	0.04	3.18	0.32
Performing arts, spectator sports, museums, and related activities	36.87	0.04	6.10	0.16
Amusements, gambling, and recreation industries	30.35	0.05	3.95	0.26
Accommodation	48.59	0.03	4.07	0.25
Food services and drinking places	27.15	0.07	4.16	0.24
Other services, except government	43.02	0.04	5.24	0.19

Table IA.5: Definition of Variables

Variables	Definition	Sources
Durability	Details refer to Section 2.1	BEA; Compustat
Depreciation	Details refer to Section 2.1	BEA; Compustat
ME (real)	Market capitalization deflated by CPI at the end of June in year t.	CRSP
B/M	The ratio of book equity of fiscal year ending in year t-1 to market equity at the end of year t-1.	Compustat
Tobin's q	The sum of market capitalization at the end of the year and book value of preferred shares deducting inventories over total assets (AT).	CRSP; Compustat
I/K	The ratio of investment (CAPX) to purchased capital (PPENT).	Compustat
ROA	The ratio of operating income before depreciation (OIBDP) over total assets (AT).	Compustat
ROE	The ratio of operating income before depreciation (OIBDP) over book equity.	Compustat
OC/AT	Following Peters and Taylor (2017).	Compustat
R&D Intensity	Following Peters and Taylor (2017).	Compustat
Tangibility	The ratio of purchased capital (PPENT) to total assets (AT).	Compustat
Book Lev.	The sum of long-term liability (DLTT) and current liability (DLCT) divided by total assets (AT).	Compustat
Short-term Lev.	Current liability (DLCT) divided by total assets (AT).	Compustat
Long-term Lev.	Long-term liability (DLTT) divided by total assets (AT).	Compustat
DIV	Following Farre-Mensa and Ljungqvist (2016).	Compustat
SA Index	Following Hadlock and Pierce (2010).	Compustat
Credit Rating	The entire list of credit ratings is as follows: AA+, AA, and AA- = 6, A+, A, and A- = 5, BBB+, BBB, BBB- = 4, BB+, BB, BB- = 3, B+, B, and B- = 2, rating below B- or missing is 0.	Compustat
WW Index	Following Whited and Wu (2006).	Compustat

References

Ai, Hengjie, Jun E Li, Kai Li, and Christian Schlag, 2020, The collateralizability premium, *The Review of Financial Studies* 33, 5821–5855.

Bharath, Sreedhar T, and Tyler Shumway, 2008, Forecasting default with the merton distance to default model, *The Review of Financial Studies* 21, 1339–1369.

Campbell, John Y, Jens Hilscher, and Jan Szilagyi, 2008, In search of distress risk, *The Journal of Finance* 63, 2899–2939.

Campello, Murillo, and Erasmo Giambona, 2013, Real assets and capital structure, *Journal of Financial and Quantitative Analysis* 48, 1333–1370.

Christiano, Lawrence J., and Jonas D. M. Fisher, 2000, Algorithms for solving dynamic models with occasionally binding constraints, *Journal of Economic Dynamics and Control* 24, 1179–1232.

Fama, Eugene F, and Kenneth R French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of financial economics* 33, 3–56.

Fama, Eugene F., and Kenneth R. French, 2015, A five-factor asset pricing model, *Journal of Financial Economics* 116, 1–22.

Fama, Eugene F, and James D MacBeth, 1973, Risk, return, and equilibrium: Empirical tests, *Journal of political economy* 81, 607–636.

Farre-Mensa, Joan, and Alexander Ljungqvist, 2016, Do measures of financial constraints measure financial constraints?, *The Review of Financial Studies* 29, 271–308.

Galindev, Ragchaasuren, and Damba Lkhagvasuren, 2010, Discretization of highly persistent correlated ar(1) shocks, *Journal of Economic Dynamics and Control* 34, 1260–1276.

Gomes, Joao F, Leonid Kogan, and Motohiro Yogo, 2009, Durability of output and expected stock returns, *Journal of Political Economy* 117, 941–986.

Griffin, John M, and Michael L Lemmon, 2002, Does book-to-market equity proxy for distress risk?, *Journal of Finance* 57, 2317–2336.

Gu, Lifeng, Dirk Hackbarth, and Tim Johnson, 2018, Inflexibility and stock returns, *The Review of Financial Studies* 31, 278–321.

Hadlock, Charles J, and Joshua R Pierce, 2010, New evidence on measuring financial constraints: Moving beyond the kz index, *Review of Financial Studies* 23, 1909–1940.

Hou, Kewei, Chen Xue, and Lu Zhang, 2015, Digesting Anomalies: An Investment Approach, *Review of Financial Studies2* 28, 650–705.

Kim, Hyunseob, and Howard Kung, 2017, The asset redeployability channel: How uncertainty affects corporate investment, *The Review of Financial Studies* 30, 245–280.

Peters, Ryan H, and Lucian A Taylor, 2017, Intangible capital and the investment-q relation, *Journal of Financial Economics* 123, 251–272.

Whited, Toni M., and Guojun Wu, 2006, Financial constraints risk, *Review of Financial Studies* 19, 531–559.

Zhang, Lu, 2005, The value premium, *Journal of Finance* 60, 67–103.