Industry competition, credit spreads, and levered equity returns

Alexandre Corhay *

November 2016

Abstract

This paper examines the effects of industry competition on the cross-section of credit spreads and levered equity returns. I build a quantitative model where firms make investment, financing, and default decisions subject to aggregate and idiosyncratic risk. Firms operate in heterogeneous industries that differ by the intensity of product market competition. Higher competition reduces profit margins and increases default risk for debtholders. Equityholders are protected against default risk due to the option value arising from limited liability. In equilibrium, competitive industries are characterized by higher credit spreads, but lower expected equity returns. I find strong empirical support for these predictions across concentration quintiles. The calibrated model also generates cross-sectional variation in leverage and valuation ratios in line with the data.

*University of Toronto - Rotman School of Management. alexandre.corhay@rotman.utoronto.ca. I thank my committee members Adlai Fisher (co-chair), Howard Kung (co-chair), and Jack Favilukis for their constant support and guidance. I also thank Frederico Belo, Murray Carlson, Andres Donangelo, Lorenzo Garlappi, Ron Gianmarino, Will Gornall, Hwagyun Kim (discussant), Kai Li, Mamdouh Medhat (discussant), Hernan Ortiz-Molina, Francesco Palomino, Carolin Pfleger, Lukas Schmid, and seminar and conference participants at Copenhagen Business School, The Federal Reserve Board, HEC Montréal, Singapore Management University, the 6th Risk Management Conference, University of Alberta, University of British Columbia, University of Hong-Kong, University of Indiana, University of Melbourne, University of Minnesota, University of Toronto, University of Virginia, University of Warwick, and the 2016 WFA meetings for helpful comments and suggestions. Any remaining errors are my own. The financial support of the Social Sciences and Humanities Research Council of Canada is gratefully acknowledged.
1 Introduction

Companies generate revenues by competing in product markets. While some firms enjoy monopoly power over the sale of their products, others face fierce competition. The intensity of competition, by affecting a firm’s profit opportunities, influences both corporate decisions and asset prices. Recently, a growing number of studies have examined the relationship between product market structure and asset prices. Yet, the existing theoretical literature has largely focused on linking competition to the unlevered equity risk. Also in the data, the effect of competition on equity returns is still debated, while its impact on credit spreads is limited. The goal of this paper is to examine how industry competition jointly affects credit spreads and levered equity returns, and to assess the importance of these channels using a quantitative model.

To analyze these issues, I develop a production based asset pricing model that captures the rich interaction between a firm’s competitive environment, optimal capital structure, default, and asset prices. The economy is populated by a large number of firms that operate in industries that differ in their degree of product market competition. They hire labor, accumulate capital, and compete with industry rivals in a Cournot-Nash framework. Each period, they choose the optimal capital structure mix by weighting the tax benefits of debt against the costs arising from default. Industry and macroeconomic quantities are obtained by aggregating individual firm decisions. Asset prices are determined in equilibrium by a representative household assumed to have recursive preferences.

I find that industry competition increases equilibrium credit spreads but decreases equity risk. To understand the economic intuition behind this result, note that in the model, industry competition affects asset prices in several ways. First, competition reduces the firm’s exposure to aggregate risk. The intuition is as follows. Because competitive firms face a more elastic demand curve, they increase current and future production more when productivity rises. At the industry level, the firm rivals also increase production, so that total industry output increases. This leads to an increase in competition and puts a downward pressure on the firm revenues. Therefore in competitive industries, rivals’ actions create a procyclical negative externality that acts as a hedge against aggregate shocks. This competitive externality channel reduces the overall risk of both levered and unlevered firms alike.

\[1\] A rare exception is the recent empirical work of Valta (2012) who finds a positive relationship between competition and interests charged on bank loans.
Second, competition decreases the value of the firm by reducing the level of operating cash flows. In the model, shareholders declare bankruptcy when the equity value becomes negative. Since competitive firms have lower valuations, they are more exposed to idiosyncratic cash-flow shocks and default more, on average. In addition, default is more likely to happen in recessions when firm continuation values are low. Taken together, the increased likelihood of default at times where recovery rates are low and the price of risk is high makes corporate bonds issued by competitive firms less desirable to investors. Competition thus increases equilibrium credit spreads. On the other side, equity holders in competitive industries own a more valuable option to default because the limited liability acts as an insurance against bad states of the world. This reduces the risk of equity. In short, the default option channel of competition increases credit spreads, but decreases equity risk.

Third, competition decreases the use of financial leverage. The intuition is readily understood. Debt financing is relatively more expensive in competitive industries, therefore competitive firms use more equity. The lower quantity of debt mitigates the effect of competition on credit spreads. However, I find that the reduction in leverage is not sufficient to make credit spreads lower in competitive industries. This happens because the cost of default, i.e. the value lost in bankruptcy, is endogenously lower for competitive firms. In the end, competitive firms issue less, but more expensive debt. The effect of competition on leverage also affects equity risk. In particular, since less competitive firms use more financial leverage, their equity risk gets higher. Consequently, the leverage channel of competition leads to an increase in equity risk in concentrated industries.

To assess the quantitative importance of these channels, I calibrate the model to match a broad set of aggregate and industry moments. In the model, the only cross-sectional difference across industries is a parameter driving industry concentration. I estimate these to match a measure of market power obtained from industries sorted on concentration. Therefore, all remaining cross-sectional differences entirely stem from differences in industry competition.

I find that competition has significant effects on corporate decisions and asset prices. In the model, the difference in credit spreads between the high- and low-competition quintile is large, around 57bps. I test this prediction in the data using a panel of publicly traded corporate bond transactions and find strong empirical evidence. Firms in competitive industries pay

---

2This holds for both equity and the unlevered firm value. In addition, although the reduction in risk tends to increase firm valuation through a discount rate channel, I find that the cash-flow channel dominates so that competition decreases the firm value. This result is consistent with empirical evidence.
25bps more on their debt\footnote{This estimate might seem low compared to the model predictions. However, as discussed later, data estimates are likely to be a lower bound measure of the effect of competition on credit spreads because my sample is biased towards the largest firms in the population.} These results are statistically significant and are robust to various measures of competition and controls. In economic terms, this represents $1.4M of additional annual interest payments for firms in more competitive environment\footnote{These values are obtained assuming a debt face value of $541M (the average face value in the sample).}. These estimates are consistent with \cite{Valta2012} who finds that competitive firms pay higher interests on bank loans. The higher cost of debt leads competitive industries to use less financial leverage. In the model the difference in market leverage between the high- and low-competition quintile is -2.3\%. These results accord with \cite{MacKayAndPhillips2005} who find that the average book leverage in more competitive industries is lower than in concentrated industries. More recently, \cite{Xu2012} reaches similar conclusions using import penetration as an instrumental variables for competition. I further confirm these findings using summary statistics from my data sample. In short, the model prediction that competition leads firms to use less, but more expensive debt is strongly supported in the data, both qualitatively and quantitatively.

The model also provides quantitative predictions for the effects of competition on the cross-section of stock returns. I find that firms in the lowest competition quintile have a lower equity premium (-0.76\%). Also, firms in more competitive industries have lower CAPM beta (-0.14). These predictions are consistent with recent empirical evidence by \cite{BustamanteAndDonangelo2015} who find a positive relationship between excess stock returns, CAPM betas and industry concentration\footnote{The credit spread premium for competitive firms is higher by a factor of 1.2. Formally, the credit spreads premium is defined as the difference between the yield on a risky bond minus the yield of riskless security that pays the expected bond payoff.}. The concentration premium arises because competition affects the firm’s exposure to industry rivals, the value of the option to default and the incentive to use leverage. Decomposing the concentration premium, I find that about 20\% comes from the competitive externality effect, and 80\% from the default and leverage channels. This highlights the importance of accounting for leverage and default in explaining the interaction between equity returns and industry competition. In contrast to equity risk, the model predicts that debt is riskier in competitive industries\footnote{In contrast, \cite{HouAndRobinson2006} find that competition increases expected returns using the population of firms in Compustat. A likely reason for this difference is that concentration measures based on public firms are biased because the decision of firms to be publicly listed is affected by the structure of the industry (e.g. \cite{BustamanteAndDonangelo2015}).}. The reason for this result is that although competitive firms have lower cash-flow risk, they default more. Since default occurs at times when the price of risk is high, this effect ultimately dominates and debt in competitive
industries is riskier.

The previous results have highlighted the importance of idiosyncratic cash-flow shocks in driving cross-sectional differences in credit spreads across competition quintiles. I extend the benchmark model with time-varying volatility for idiosyncratic shocks and find that credit spreads in competitive industries are more sensitive to change in idiosyncratic volatility. To understand the intuition, it is useful to remember that corporate debt can be modeled as a default-free bond minus a put option on the firm assets (e.g. Merton (1974)). Tougher competition, by reducing the firm value, brings the firm closer to default, i.e. the strike price. The sensitivity of the put option to change in volatility is thus amplified for more competitive firms. I confirm this prediction in the data. Using a moving standard deviation of abnormal returns as proxy for idiosyncratic volatility, I find that a 1% increase in idiosyncratic volatility is associated to an additional 21bps increase in credit spreads in competitive industries. In terms of portfolio performance, a corporate bond portfolio of debt issued by competitive firms loose an additional 1.49% return for each 1% increase in idiosyncratic volatility. These results are robust to different measures of competition and various controls, including firm fixed effects.

1.1 Literature review

The present paper contributes to the literature that links product market competition to firm risk and stock returns. Early empirical work by Hou and Robinson (2006) finds that competition increases expected stock returns using Compustat-based measures. Bustamante and Donangelo (2015) reach opposite conclusions, using broader measures of concentration that include private firms. The later explain this discrepancy by noting that the decision to be publicly listed depends on industry characteristics, which can bias concentration measures. Aguerrevere (2009) examines how competition affects equity risk in a simultaneous-move oligopoly. Bena and Garlappi (2011), and Carlson, Dockner, Fisher, and Giammarino (2014) considers risk dynamics in a leader-follower equilibrium. Bustamante and Donangelo (2015), and Loualiche (2014) studies the effects of entry on the cross-section of stock returns. Corhay, Kung, and Schmid (2015) links competition to time-varying risk premia and return predictability. My work fills an important gap in this literature by analyzing how product

---

7These calculations are obtained by computing the realized return on a bond whose characteristics are set to the sample average and assuming a 1% increase in idiosyncratic volatility.
market structure jointly affects the pricing and risk of corporate debt and levered equity.\footnote{Other related papers include Garlappi (2004), Hackbarth and Morellec (2008), Hoberg and Phillips (2010), Ortiz-Molina and Phillips (2014), Bustamante (2015).}

The literature in corporate finance and IO examining the interactions between capital structure and product markets is vast. While most prior studies have focused on the impact of capital structure on firm strategies in product markets,\footnote{Some examples are Brander and Lewis (1987), Bolton and Scharfstein (1990), Chevalier (1995), Phillips (1995), Lambrecht (2001), and Campello (2003).} a growing research (e.g., MacKay and Phillips (2005)) has highlighted the importance of industry competition on capital structure. Xu (2012) shows empirically that higher industry competition decreases the use of leverage. Valta (2012) shows that more competitive firms face a higher cost of bank loans. This paper contributes by investigating the effects of industry competition on the quantity and pricing of debt in a joint framework. In addition, the quantitative model provides structural evidence that differences in industry concentration have first-order effects on corporate policies and asset prices.\footnote{Also related is Miao (2005) that investigates the interaction between industry dynamics and capital structure in a model with entry and exits. Other papers examine the effect of competition on other corporate decision such as investment (e.g., Simintzi (2013), and Frésard and Valta (2014)).}

My work also builds on the literature in economics and finance embedding dynamic capital structure decision\footnote{See Strebulaev and White (2011) for a recent literature review.} into equilibrium asset pricing models. Hackbarth, Miao, and Morellec (2006) highlights the importance of macroeconomic conditions for firm financing conditions and credit spreads in a risk-neutral framework. Building on their work, several papers have tried to rationalize the credit spread puzzle by generating variation in the market price of risk over the business cycle. Chen, Collin-Dufresne, and Goldstein (2009) accomplishes this using the habits formation model of Campbell and Cochrane (1999), while Bhamra, Kuehn, and Streublaev (2009) adopts the long-run risks framework of Bansal and Yaron (2004). Chen (2010) shows how countercyclical variations in default losses helps generating a significant bond risk premia.\footnote{Other related studies include Almeida and Philippon (2007), Davydenko and Streublaev (2007), Elkamhi, Ericsson, and Jiang (2011). In these papers, the state-price density or endowment process is assumed to be exogenous.}

In a recent paper, Gilchrist and Zakrjas (2011) show that corporate bond risk premia contains important information about the business cycles. Motivated by these findings, a growing body of literature now attempts to connect corporate bond risk premium to the economy. This is especially important as most of the production-based asset pricing litera-
ture has focused on linking the macroeconomy to equity risk premia. Recent contributions include [Gomes, Jermann, and Schmid (2013)] who incorporate long-term nominal debt into a standard DSGE model to quantify the importance of nominal rigidity through a debt deflation channel. [Miao and Wang (2010)] adopts a similar setup and shows how long-term debt amplifies business cycle fluctuations. Several other papers have proved successful at generating significant credit risk premium in production models: [Gourio (2013)] uses disaster risk, [Gomes and Schmid (2010)] model heterogeneous firms, and [Favilukis, Lin, and Zhao (2013)] highlights the importance of labor frictions. My work contributes to this literature by departing from the assumption of perfect competition and by examining how the product market structure affects credit spreads in the cross-section.

Finally, the paper relates to studies linking equity volatility to corporate credit spreads, e.g. [Campbell and Taksler (2003)]. A series of recent paper documents the tight connection between competition and idiosyncratic volatility (e.g. [Gaspar and Massa (2006)] and [Irvine and Pontiff (2009)]). In this paper, I contribute to the literature by showing, both theoretically and empirically, how competition can amplify credit spread’s exposure to idiosyncratic risk. Importantly, I also document that the increased exposure to idiosyncratic volatility translates into lower equity risk premium for competitive industries.

The paper is organized as follows. Section 2 develops a simple two-period model where I derive closed form solution on the effects of competition on asset prices. Section 3 extends the simple model into a quantitative model. In section 4, I discuss the baseline calibration. Section 5 investigates some of the model’s quantitative implications for the cross-section of asset prices. Section 6 presents several empirical tests and is followed by a few concluding remarks in section 7.

2 A simple model

This section develops a simple, two-period model to highlight some of the key economic channels through which competition affects the pricing of equity and debt. These ingredients are then incorporated in a more quantitative setting in the next section.

---

14More broadly, the paper also relates to the macroeconomic literature studying the effects of financial constraints in quantitative general equilibrium business cycle models. Early examples in the literature are Kiyotaki and Moore (1997) and Bernanke, Gertler, and Gilchrist (1999). More recent work includes Christiano, Motto, and Rostagno (2010) and Jermann and Quadrini (2012).
2.1 Economic environment

Consider an oligoplistic industry that is populated by \( n \) value-maximizing firms. These firms strategically compete in the product markets in a Cournot-Nash setup as in Aguerrevere (2009). In particular, it is assumed that firms play a static Cournot game in each period. They choose the quantity of output to maximize the value of the firm, taking production decisions of other firms as given. For simplicity, I assume the existence of a risk-neutral representative investor whose time discount factor \( \beta \) is used to price all securities. The timeline of events is as follows. In period 0, the firm hires labor after observing the realization of an aggregate technology shock. The firm finances itself by issuing one-period debt and equity. In period 1, the firm makes optimal production decisions after which it is hit by an idiosyncratic shock. Shareholders then have the option to declare bankruptcy. If no default occurs, the firm pays its debt obligations, and distribute all residual claim as dividend. The firm then disappears from the economy.

To be more specific, each firm in the industry produces an identical good \( y_{i,t} \). The total demand for the industry is given by the following downward-sloping demand curve,

\[
Y_t = P_t^{-\nu} \mathcal{Y}_t
\]

where \( \nu \) is the elasticity of demand for the industry good, \( P_t \) is the equilibrium industry good price, \( Y_t = \sum_{i=1}^n y_{i,t} \) is the total industry output, and \( \mathcal{Y}_t \) is an aggregate demand term, taken as given by the firm.\(^{15}\)

The firm produces output using labor \( l_t \) that is rented in competitive markets at a wage rate of \( W_t \). The production technology is assumed to be linear in labor,

\[
y_t = A l_t
\]

where \( A \) is a persistent (i.e. lasts two periods) technology shock capturing all systematic risk in the economy.

In period 0, the firm decides on its optimal capital structure by issuing one-period defaultable debt \( b \) and equity (negative dividends). Debt is attractive because of the tax deductibility of interest rates but is costly because default entails dead-weight costs. In particular, when

\(^{15}\)To facilitate the exposition, the \( i \)-subscript is dropped, unless it is necessary to avoid confusion.
the value of the firm becomes negative, shareholders walks away with a payoff of zero, and debtholders get nothing. Denoting the unit price of debt by \( q \), the value of corporate debt to investors is,

\[
q = \beta \Phi(z^*)(1 + C)
\]  

(3)

where \( \Phi(z^*) \) is the probability of survival of the firm (to be determined later), and \( C \) is the coupon payment. Essentially, Eq. 3 says that the value of debt today is the expected payoff, discounted by the state-price density, \( \beta \).

### 2.2 Individual firm’s problem

The objective of the firm is to maximize the market value to shareholders \( V_j \), by choosing labor, and the optimal capital structure:

\[
V_j = \max_{l_0, l_1, b_0, b_1} \left[ \frac{d_0 + \beta E_0[\max\{d_1, 0\}]}{\beta} \right]
\]  

(4)

subject to the total demand for the industry good (Eq. 1), the market value of corporate debt (Eq. 3), and production decisions of other firms. Note that the second max operator captures the limited liability option of shareholders. The firm dividends are defined as the free cash-flows generated by the firm. Because of the finite nature of the firm, there will be no debt issuance in period 1. The real dividend in each period is given by

\[
\begin{align*}
    d_0 &= P_0 y_0 - W_0 l_0 + q b \\
    d_1 &= P_1 y_1 - W_1 l_1 - z \bar{l} - (1 + C(1 - \tau)) b_1
\end{align*}
\]  

(5)  

(6)

where \( (1 - \tau) \) captures the tax advantage of interest payments, and \( z \) is a mean-zero, idiosyncratic shock assumed to be uniformly distributed on \([-a/2, a/2]\). The idiosyncratic shock \( z \) is multiplied by the average size of a firm in the industry, \( \bar{l} = \frac{1}{n} \sum_{i=1}^{n} l_{i,t} \) to avoid that competitive industries be mechanically more exposed to \( z \) shocks. In the following, I denote the cumulative distribution of \( z \) by \( \Phi(.) \), and the associated probability distribution function by \( \phi(.) \). The idiosyncratic cash-flow shock \( z \) captures, in a reduced form, all heterogeneity across

---

10All nominal variables, except for the output price, are normalized by the equilibrium industry price. It is assumed to be taken as given by the individual firm.
firms and is the key ingredient that drives firms to default. In particular, the bankruptcy
decision consists of a threshold rule where shareholders declare bankruptcy as soon as \( z \) is
larger than a default threshold \( z^* \), where \( z^* \) is such that \( d_1(z^*) = 0 \).

### 2.3 Equilibrium

In the model, all firms are the same except for their idiosyncratic shock realization. Because
this cost enters as a fixed cost, all firms make identical decisions. Therefore the model admits a
unique symmetric Nash equilibrium, where all firms maximize their firm value, taking rivals’
actions as given. To close the labor market, I assume that the total labor supply in the
industry is equal to 1. I leave the derivation of the solution to the appendix.

The equilibrium is described by a set of three equations, one optimality condition for
labor, one for debt, and an optimal default threshold. This implies the following equilibrium
profit margin:

\[
PM = \frac{h}{\nu}
\]  

(7)

where \( h = \sum_{i=1}^{n_y} (y_{i,t}/Y_t)^2 \) is the industry Herfindahl-Hirschman concentration index. \( h^{-1} \) is
a measure of industry competition. Note that the firm profit margin is increasing in industry
concentration. Intuitively, when competition is tougher, a single firm has less control on the
industry price \( P_t \), and faces a more elastic demand curve. Therefore higher competition
drives each individual firm to produce more. At the industry level, all firms produce more
so that the increased industry production puts a downward pressure on revenues and reduces
the firm profits.

### 2.4 Competition, corporate policies and asset prices

This section examines the effect of industry competition on equilibrium corporate policies,
credit spreads and equity. Proposition 1 summarizes several key results.

**Proposition 1.** An increase in industry competition: (i) increases the expected default prob-
ability, (ii) decreases financial leverage, (iii) decreases equity value, and (iv) increases credit
spreads.\(^{18}\)

\(^{17}\)To be more specific, the elasticity of demand for an individual firm is \( \eta_{y_j} \rho = \frac{\nu}{\beta} \).

\(^{18}\)Note that I’m working under the assumption that \( \beta > 0, C > 0, \tau > 0, \nu > 1 \). Also, note that these
results hold quite generally for all distribution functions \( \Phi(.) \) such that \( \frac{\Phi(z)}{\phi(z)} \) is increasing in \( z \). This is the case
Proof. See appendix

To understand the intuition behind these results note that, as shown in Eq. 7, competition erodes firms’ profit margins. This makes competitive firms more exposed to idiosyncratic cash-flows shocks and increases the expected probability of default. Creditors are rational and discount the value of corporate bonds issued by competitive firms. Consequently, equilibrium credit spreads rise. In response to the more expensive cost of debt, shareholders cut on leverage. However, the reduction in leverage is not sufficient to decrease credit spreads because equity holders are willing to accept additional cost of financing to capture some of the tax benefits of debt. In the end, competitive firms earn lower profits, default more, and generate less tax shield from leverage, making their equity value lower.

Another measure of interest is equity risk. More formally, equity risk can be measured by the firm conditional beta \( \beta_i \), calculated as the elasticity of equity with respect to the systematic shock \( A \). It can be shown that the conditional beta is composed of three components (see appendix for details),

\[
\beta_i = 1 - \frac{\beta}{V_j} \int_{-\infty}^{\infty} z \Phi(z) + \frac{\beta rC}{1 + (1 - \tau)C} \Phi(z^*) z^* \tag{8}
\]

The first term is the equity beta of an unlevered firm without idiosyncratic shocks. It is equal to one because in this case, the firm value is linear in \( A \). The second term captures the effect of default on equity risk. This term is negative, that is, the option to default decreases equity beta. The intuition is that the limited liability of shareholders acts as an insurance against bad states of the world, making equity safer. Finally, the third term captures the risk coming from the expected tax-shield. This term contributes positively to \( \beta_i \) because the net benefit of debt is procyclical.

In contrast to credit spreads, industry competition decreases equity risk. The reason for this result is two-fold. First, because competitive firms face a higher likelihood of default, their limited liability option is more valuable. This decreases equity risk through a default for most standard distribution function such as normal, uniform, etc.  

\(^{19}\)To be more precise, the risk premium on the asset is \( \beta_i \lambda \), where \( \lambda \) is the market price of the systematic risk. In this simple model, the price of risk is null because of the risk-neutrality assumption. Therefore exposure to the \( A \) shock is not risky per se. The model could easily be augmented to have a positive price of risk without changing the qualitative results. To keep exposition as simple as possible I abstract from this and keep referring to \( \beta_i \) as capturing equity risk.
option channel. Second, because competition reduces the use of debt, they are less exposed to the risk stemming from the expected tax-shield. This further decreases equity risk through a leverage channel. So far, we have abstracted from investment, a key ingredient in the benchmark model. Allowing firms to invest in extra capacity leads to an additional effect of competition which I refer to as the competitive externality channel. I discuss this third channel in the next section.

2.5 Investment

The previous section illustrates how competition, by reducing the level of profits, makes firm more exposed to idiosyncratic cash-flow shocks. Competition increases credit spreads because the likelihood of default is higher. Yet, it reduces equity risk because the default option becomes more valuable and competitive firms use less financial leverage. In this section, I discuss how allowing for investment gives rise to another effect of competition on asset prices; namely, competition decreases the riskiness of the firm cash flows.

The intuition is as follows. Firms in competitive industries face a more elastic demand curve. Consequently, they increase investment relatively more in response to positive news about productivity. At the industry level, all firms adopt a similar strategy such that total industry output increases. This puts a downward pressure on the output price (see Eq. 1). In the end, competitive firms produce more and sell at a cheaper price. Because the marginal product of capital is decreasing, competitive industries are characterized by less procyclical profits. Therefore when investment is allowed, feedback effects from industry rivals curtail potential profit opportunities from investment, and decreases the firm exposure to aggregate risk. I refer to this effect as the competitive externality channel.

The simple model has highlighted several channels through which competition affects levered equity returns and credit spreads. In the next section, I build a production-based asset pricing model to quantitatively assess the strengths of each these channels.

---

20The idea that rivals’ actions can reduce own-firm risk arises in other setups. For instance, Carlson, Dockner, Fisher, and Giammarino (2014) obtain similar results in dynamic duopoly model where firms have the option to invest in additional capacity (intensive margin). More recently, Bustamante and Donangelo (2015) uses procyclical entry threat (extensive margin).
3 Benchmark model

I now extend the simple two-period model into a quantitative dynamic stochastic general equilibrium model. The economy is composed various industries in which firms compete in product markets. These firms issue debt and equity and are owned by risk-averse investors. Figure 1 gives an overview of the economic environment. The goal here is to test whether the channels highlighted previously are quantitatively sufficient to explain the cross-sectional differences in industries sorted on industry concentration.

3.1 Firms

This section describes the economic environment faced by an individual firm $i$ operating in an industry $j$. The industry is composed of $n_j$ firms which compete for the sale of an identical industry good. As before, competition in product markets is captured by assuming that firms play a Cournot game in each period. The number of firms $n_j$ is the only difference across industries and captures differences in industry competition. In particular, higher $n_j$ industries are characterized by tougher competition. For simplicity, I assume that $n_j$ is fixed. The total demand for industry goods, $Y_{j,t}$, obeys the following inverse demand curve,

$$Y_{j,t} = \tilde{P}_{j,t}^{-\nu} \mathcal{Y}_t$$

where $\mathcal{Y}_t$ is an aggregate demand term, $Y_{j,t} = \sum_{i=1}^{n_j} y_{i,j,t}$ is the total industry output, $\tilde{P}_{j,t} = P_{j,t}/P_t$ is the price of the industry good, relative to the economy price index $P_t$, and $\nu$ is the elasticity of demand for industry goods. For now, I take this demand function as given. At the end of the section, I provide an industry structure to rationalize this specification.

**Technology** Intermediate firm $i$ in industry $j$ uses capital $k_{i,j,t}$ and labor $l_{i,j,t}$ as input in a Cobb-Douglas production technology:

$$y_{i,j,t} = k_{i,j,t}^\alpha (A_l l_{i,j,t})^{1-\alpha}$$
where $A_t$ represents an aggregate productivity shock common across firms, and is composed of a short- and long-run risk components:

\[
\Delta a_{t+1} = \mu + g_t + \sigma a \epsilon_{a,t+1} \tag{11}
\]

\[
g_t = \rho g_{t-1} + \sigma g \epsilon_{gt} \tag{12}
\]

where $\Delta a_t = \ln(A_t) - \ln(A_{t-1})$, and $\epsilon_{at}$ and $\epsilon_{gt}$ are uncorrelated standard normal shocks i.i.d. shocks. The low-frequency component in productivity, $g_t$, is used to generate sizeable risk premia as in Bansal and Yaron (2004).

**Firm’s operating profit** The firm hires $l_{i,j,t}$ units of labor from households at a competitive wage of $W_t P_t$. Each unit of goods is sold to customers at a unit price of $P_{j,t}$. Following Gomes, Jermann, and Schmid (2013), heterogeneity across firms is captured by assuming that operating profits are hit by an idiosyncratic, mean zero, i.i.d. shock $z_{i,j,t}$. These shocks summarize, in a reduced form, all idiosyncratic risk affecting a firm’s cash flows. The real operating profit before tax is

\[
\Pi_{i,j,t} = \tilde{P}_{j,t} y_{i,j,t} - W_t l_{i,j,t} - z_{i,j,t} \bar{k}_{j,t} \tag{13}
\]

where $\bar{k}_{j,t}$ is the average capital stock in the industry. In the following, I denote by $\Phi(.)$ and $\phi(.)$ the cumulative and density distribution function of the idiosyncratic shock $z$ which is defined over the support $[z, \bar{z}]$. Eq. 13 means that operating profits are equal to total sales, minus the total cost of labor, minus a firm-specific shock, assumed to be uncorrelated both serially and cross-sectionally.

**Financing** Each period, after observing realizations of all shocks, the owner of the intermediate firm decides on whether to default or not. If no default occurs, the firm chooses its optimal capital structure by issuing new debt, $b_{i,j,t+1}$, and equity to finance its operations. In case of default, the owner walks away with a payoff of zero and creditors take over the firm.

---

21 Other studies using this type of productivity process include Croce (2014), Kung (2015), and Kung and Schmid (2015).

22 One needs to multiply $z_{i,j,t}$ by some non-stationary variables to avoid that idiosyncratic risk becomes trivially small along the balanced growth path. Furthermore, multiplying by the average size of a firm avoids that competitive industries be mechanically more exposed to idiosyncratic shocks.

23 In practice, shareholders can receive a positive amount in case of default (e.g. Garlappi and Yan (2011)). Accounting for this has no bearing on the main results.
after paying some bankruptcy cost.

Before issuing new debt, the firm is required to pay the interest and the principal due on its outstanding one-period debt,

\[(1 - \tau)C + 1) b_{i,j,t}\]  

(14)

where \(b_{i,j,t}\) is the total amount of real corporate debt issued at \(t - 1\), \(C\) is the coupon payment on existing debt, and \(\tau\) is the corporate tax rate. When no default occurs, the firm issues new debt \(b_{i,j,t+1}\) at a market price of \(q_{i,j,t}\) per unit of debt. Finally, all costs associated with adjustments to leverage are captured by a cost function \(\psi(b_{i,j,t}, b_{i,j,t+1})\). Therefore the net cash flow from debt financing activities is

\[b_{i,j,t+1}q_{i,j,t} - ((1 - \tau)C + 1) b_{i,j,t} - \psi(b_{i,j,t}, b_{i,j,t+1})\]  

(15)

**Investment**  The firm accumulates capital for production in the next period through capital investment, \(I_{i,j,t}\). The stock of productive capital accumulates as follow,

\[k_{i,j,t+1} = (1 - \delta_k)k_{i,j,t} + \Gamma \left( \frac{I_{i,j,t}}{k_{i,j,t}} \right) k_{i,j,t}\]  

(16)

where \(\delta_k\) is the depreciation rate of capital, and \(\Gamma(.)\) captures the idea that capital accumulation is subject to adjustment costs. As in reality, it is assumed that the firm can deduct depreciated capital from taxable income. The net cash flows from investment activities is

\[-I_{i,j,t} + \tau\delta_k k_{i,j,t}\]  

(17)

**Equity value**  Equity holders have the right to the firm dividends so long as the firm is in operation. The dividend is equal to firm free cash-flows that is, the operating profit, net of cash flows from financing and investment activities,

\[D_{i,j,t} = (1 - \tau)\Pi_{i,j,t} - I_{i,j,t} + \tau\delta_k k_{i,j,t} - ((1 - \tau)C + 1) b_{i,j,t} + q_{i,j,t}b_{i,j,t+1} - \psi_{b,i,j,t}\]  

(18)

The objective of the firm manager is to maximize the equity value defined as the present

---

\footnote{One could obtain financing frictions in other ways. For instance \text{Jermann and Quadrini (2012)} assume quadratic adjustment costs for dividends, and \text{Gomes, Jermann, and Schmid (2013)} use long-term nominal debt.}
value of dividends, subject to the capital accumulation equation and the inverse demand for the firm goods. Denoting the vector of aggregate state variables and production decisions of rivals by \( \Upsilon_j \equiv \{ k_{j,t}, \gamma_t, g_t, \Delta a_t, \{ y_{k,j,t} \}_{k=1,k \neq j}^{n_j} \} \), the firm problem is

\[
E (b_{i,j,t}, k_{i,j,t}, z_{i,j,t}, \Upsilon_j) = \max \left\{ \max_{\{ \tilde{F}_{i,j,s} \}_{s=t}^{\infty} E_t \left[ \sum_{s=0}^{\infty} M_{t,t+s} D_{i,j,t+s} \right], 0 \right\}
\]

s.t. \( k_{i,j,t+1} = (1 - \delta k) k_{i,j,t} + \Gamma \left( \frac{I_{i,j,t}}{k_{i,j,t}} \right) k_{i,j,t} \)

\[
Y_{j,t} = \tilde{P}_{j,t} \gamma_t
\]

where \( \tilde{F}_{i,j,s} \equiv \{ b_{i,j,s+1}, I_{i,j,s}, k_{i,j,s+1}, l_{i,j,s} \} \) is a vector containing all the firm controls, and \( M_{t,t+s} \) is the equilibrium stochastic discount factor. Note that the first max operator captures the limited liability of shareholders, and the second max operator relates to the optimal decision of the manager.

**Default decision** When the value of the firm becomes negative, shareholders declare bankruptcy and leave with a payoff of zero. Let’s define \( V (b_{i,j,t}, k_{i,j,t}, z_{i,j,t}, \Upsilon_j) \) to be the present discounted value of dividends (the term inside the first max in Eq. 19). The default decision consists in finding the threshold value \( z^*_{i,j,t} \) such that \( V (b_{i,j,t}, k_{i,j,t}, z^*_{i,j,t}, \Upsilon_j) = 0 \) and declaring bankruptcy when \( z_{i,j,t} > z^*_{i,j,t} \). The assumption that \( z_{i,j,t} \) enters as an i.i.d. fixed cost makes the value of the firm additive in \( z_{i,j,t} \)\(^{25}\) and we can solve easily for \( z^*_{i,j,t} \):

\[
z^*_{i,j,t} = \frac{V (b_{i,j,t}, k_{i,j,t}, 0, \Upsilon_j)}{(1 - \tau) \bar{k}_{j,t}}
\]

Eq. 20 highlights the fact that the optimal default threshold depends on the firm valuation. This will be important to generate countercyclical default rates as in the data.

**Debt value** When the firm defaults, creditors gain control over the firm assets after paying a one time cost of \( \xi \) of the firm value. They become owner of an unlevered firm and collect the firm’s profit in the current period. Corporate bonds are held by the representative household and are thus valued using the household equilibrium pricing kernel \( M_{t,t+1} \). The value of newly issued debt to creditors is

\[\text{In particular, } V (b_{i,j,t}, z_{i,j,t}, \Upsilon_j) = V (b_{i,j,t}, 0, \Upsilon_j) - (1 - \tau) z_{i,j,t} \bar{k}_{j,t}.\]
\[ q_{i,j,t}b_{i,j,t+1} = E_t M_{t,t+1} \left\{ \Phi(z_{j,t+1}^*)(C + 1)b_{i,j,t+1} 
+ (1 - \xi_t) \int_{z_{j,t+1}}^{z_{j,t+1}^*} V(0, z_{j,t+1}, Y_{t+1}) \, d\Phi(z_{j,t+1}) \right\} \] (21)

The first term inside the brackets is the payment when the firm survives multiplied by the probability of survival. It is equal to the coupon payment plus the principal. The second term is the bondholders payoff when the firm defaults, multiplied by the probability of default.

**Optimal firm decisions** The objective of the manager is to make a series of operating, financing and investment decisions to maximize the value of the firm. The Lagrangian and derivations of the first order necessary conditions are detailed in appendix B.

Let’s first examine the optimal capital structure decision. The leverage decision is given by the first order condition with respect to \( b_{i,j,t+1} \),

\[ q_{i,j,t} + \frac{\partial q_{i,j,t}}{\partial b_{i,j,t+1}} b_{i,j,t+1} = E_t M_{t,t+1} \Phi(z_{j,t+1}^*)[(1 - \tau)C + 1] + \Delta \psi_{b,t} \] (22)

where \( \Delta \psi_{b,t} \)\(^{26} \) is the net cost associated with issuing an amount \( b_{i,j,t+1} \) of debt. This condition means that in equilibrium, the firm equates the marginal benefits (left-hand side) to the marginal costs (right-hand side) of debt. More specifically, issuing an additional unit of debt provides shareholders with an additional payoff equal to \( q_{i,j,t} \), adjusted to take account of the decrease in debt value due to the increased probability of default. The cost of issuing an additional unit of debt is the after-tax interest rate, plus the principal due in the next period, plus the change in issuance cost. These costs are multiplied by the probability of survival as shareholders have the option to walk away in the next period. Worth noticing is that equity holders rationally take account of the impact of their choices on the cost of debt, i.e. \( \frac{\partial q_{i,j,t}}{\partial b_{i,j,t+1}} \).

The optimal investment decision is obtained by equating the marginal benefits to the marginal costs of an additional unit of capital,

\[ \Lambda^K_{i,t} = E_t M_{t,t+1} (1 + \vartheta_{i,j,t+1}) \left\{ D'_{k,i,j,t+1} + \Lambda^K_{i,t+1} \left[ 1 - \delta_k + \Gamma_{i,j,t+1} - \Gamma'_{i,j,t+1} \left( \frac{i_{t+1}}{k_{t+1}} \right) \right] \right\} \] (23)

where \( \vartheta_{i,j,t+1} = \phi(z_{i,j,t+1}^*) \frac{h_{i,j,t+1}}{(1 - \tau)k_{j,t}} (\tau C + \xi_t + 1) - \xi_{t+1}(1 - \Phi(z_{j,t+1}^*)) \) and \( \Lambda^K_{i,t} \) is the Lagrange multiplier on the capital accumulation equation and represents the shadow value of an additional marginal unit of capital (Tobin’s Q). The two terms inside the brackets in Eq. 23

\(^{26} \)In particular, \( \Delta \psi_{b,t} = \frac{\partial \psi_{b,t}}{\partial b_{i,j,t+1}} + E_t M_{t,t+1} \Phi(z_{j,t+1}^*) \frac{\partial \psi_{b,t+1}}{\partial b_{j,t+1}} \).
represents the expected increase in dividend and capital gains from investing a marginal unit of capital today. The multiplicative term $(1 + \vartheta_{i,j,t+1})$ captures the distortion arising from the leverage decision. More specifically, investing today increases future dividends and thereby decreases the probability of default (first term in $\vartheta_{i,j,t+1}$). Besides, because bankruptcy is costly, there is a chance that the invested unit is going to be lost partially in the next period (second term). Note that the standard investment Euler equation is a particular case where $\vartheta_{i,j,t+1} = 0$.

### 3.2 Industries dynamics and competition

The final consumption good is produced by a representative firm operating in a perfectly competitive market. The firm uses a continuum of industry goods $Y_{j,t}$ as input in a CES production technology. To keep the number of industries finite, it is assumed that the economy is composed on $N$ different industries equally distributed on the $[0,1]$ interval,

$$Y_t = \left( \int_0^1 Y_{j,t}^{\frac{\nu-1}{\nu}} \, dj \right)^{\frac{\nu}{\nu-1}} = \left( \frac{1}{N} \sum_{i=1}^N Y_{j,t}^{\frac{\nu-1}{\nu}} \right)^{\frac{\nu}{\nu-1}}$$

(24)

where $\nu$ is the elasticity of substitution between goods of different industries.

Solving the profit maximization problem for the final good firm (see Appendix C) yields the following inverse demand function for goods in industry $j$,

$$Y_{j,t} = \tilde{P}_{j,t}^{-\nu} Y_t$$

(25)

where $\tilde{P}_{j,t} = P_{j,t}/P_t$, and $P_t = \left( \int_0^1 P_{j,t}^{1-\nu} \, dj \right)^{\frac{1}{1-\nu}}$ is the aggregate price index. Note that this is the same inverse demand function as the one specified in Eq. [6].

### 3.3 Households

The model is closed by specifying the household industry. I assume the existence of a representative household with recursive utility over a bundle of consumption $C_t$ and leisure $(1 - L_t)$.

---

27Specifically, $D'_{k,i,j,t} = (1 - \tau) \tilde{P}_{j,t} \left[ 1 - \frac{\nu}{\nu-1} \frac{Y_{j,t}}{P_t} \right] \alpha \frac{W_t}{k_t} + \tau \delta_k$
as in Croce (2014),

\[
U_t = \begin{cases} 
C_t^{1-\frac{1}{\psi}} + \beta E_t \left[ U_{t+1}^{1-\frac{1}{\gamma}} \right]^{\frac{1}{1-\gamma}} 
\end{cases}^{1-\frac{1}{\psi}} 
\]

\[
C_t = C_t^{\varphi} (A_{t-1} (1 - L_t))^{1-\varphi} 
\]

where \( \gamma \) is the coefficient of relative risk aversion, \( \psi \) is the elasticity of intertemporal substitution, \( \beta \) is the subjective discount factor, and \( \varphi \) drives the total amount of hours worked. Note that leisure is multiplied by productivity \( A_{t-1} \) to ensure balanced growth.

To finance her consumption stream, the representative household collects wages by supplying specialized labor \( L_{j,t} \) to industry \( j \). In addition, the household has access to financial markets where she can invest in stocks, and corporate bonds in all industries as well as government bonds. The total position held in equities is denoted by \( Q_t \), while the total amount invested in corporate and government bonds is denoted by \( B_{t+1}^c \) and \( B_{t+1}^g \), respectively. The real (normalized by \( P_t \)) budget constraint of the household is

\[
C_t + \left[ B_{t+1}^c + B_{t+1}^g + Q_t \right] = W_t L_t + \left[ R_t^c B_t^c + R_t^f B_t^f + R_t^d Q_{t-1} \right] - T_t 
\]

where \( W_t L_t = \frac{1}{N} \sum_{j=1}^{N} W_{j,t} L_{j,t} \) is the total labor income, \( R_t^f \) is the risk-free return on government bonds bought in the previous period, and \( R_t^d \) and \( R_t^c \) are the total returns on the equity and corporate debt portfolio. These returns are defined in the next section. \( T_t \) are lump-sum government taxes.

Solving the household problem yields a set of Euler equation to price all the securities in the economy. The equilibrium one-period pricing kernel is

\[
M_{t,t+1} = \beta \left( \frac{C_{t+1}}{C_t} \right)^{-1} \left( \frac{\bar{C}_{t+1}}{\bar{C}_t} \right)^{1-\frac{1}{\psi}} \left( \frac{E_t \left[ U_{t+1}^{1-\frac{1}{\gamma}} \right]}{U_{t+1}^{1-\frac{1}{\gamma}}} \right)^\frac{1}{1-\gamma} 
\]
The household labor supply for each industry is,

\[ W_{j,t} = \left( \frac{1}{\varphi} - 1 \right) \frac{C_t}{(1 - L_t)} \]  

(30)

Because the household works indifferently in all industries, the aggregate wage will be the same across all industries.

### 3.4 Equilibrium and aggregation

As in the simple model, the fixed cost specification for the idiosyncratic risk makes all firms ex-ante identical. Besides, in case of bankruptcy, the firm is transferred to debt-holders who make the same decisions as surviving firms. Therefore, the only cross-sectional difference across firms comes from the realization of the firm-specific shock \( z_{i,j,t} \). In the aggregate, the law of large numbers applies to each type of industry \( j = 1, ..., N \) and we only need to keep track of the measure of defaulting firms each period, \( 1 - \Phi(z^*_j,t) \). Therefore each industry admits a symmetric Nash equilibrium and the \( i \)-subscript can be dropped. In the symmetric equilibrium, the model has \( 2 \times N + 2 \) state variables; two endogenous state variables for each industry \( (\bar{k}_{j,t}, b_{j,t}) \), and two exogenous variables \( (g_t, \Delta a_t) \) for the economy.

**Asset returns** The return on equity and corporate debt in industry \( j \) are defined in a standard way and account for the proportion of firms that defaults,

\[
R^d_{j,t} = \int_{z_*}^{z_{j,t}} [D_{j,t} + Q_{j,t}] d\Phi(z) / Q_{j,t-1}
\]

\[
R^c_{j,t} = \Phi(z^*_j,t)(C + 1)b_{j,t} + \int_0^{z_j,t+1} (1 - \xi_t)V^U_{j,t} d\Phi(z) / B^c_{j,t-1}
\]

(31)

where \( Q_{j,t} = V_{j,t} - D_{j,t} \) is the ex-dividend value of equity in industry \( j \), and \( V^U_{j,t} \) is the equity value cum-dividend of an unlevered firm.

**Resource constraint** Using the definition for the returns \([31]\) earned in financial markets and imposing market clearing on all markets. The aggregate resource constraint \([28]\)

\[ B^c_{t+1} = \sum_{j=1}^N q_{j,t} b_{j,t+1} \]
becomes,

\[ Y_t = C_t + I_t + \Psi_{b,t} + \Xi_t \]  

(32)

where \( I_t = \frac{1}{N} \sum_{i=1}^{N} I_{j,t} \) is aggregate investment, \( \Psi_{b,t} = \frac{1}{N} \sum_{i=1}^{N} \psi_b(b_{i,j,t}, b_{i,j,t+1}) \) is the amount of resources spent in debt adjustments, and \( \Xi_t = \frac{1}{N} \sum_{i=1}^{N} \left( \int_{z_{j,t+1}}^{\infty} \xi_t V_{j,t}(0,z) d\Phi(z) \right) \) is the aggregate resource lost in bankruptcy.

**Industry pricing** In the symmetric Nash equilibrium, the industry price is defined as a markup over the industry marginal cost. In particular, denoting the real marginal cost of production by \( MC_{j,t} = \frac{W_z}{(1-\alpha) \tilde{t}_{j,t}} \),

\[ \tilde{P}_{j,t} = MC_{j,t} \left( 1 - \frac{h_j}{\nu} \right)^{-1} \]  

(33)

where \( h_j \) is the Herfindahl-Hirschman index in industry \( j \). Note that \( \tilde{P}_{j,t} \) is increasing in industry concentration. The intuition is that when less players compete in product markets, firms behave more like monopolist and charge a higher markup.

### 4 Model parametrization

This section describes the benchmark model calibration and provides details on the functional forms for the adjustment costs and idiosyncratic shocks distribution. The model is solved using a second order perturbation method about the steady state after normalizing all non-stationary variables by \( A_{t-1} \).

#### 4.1 Functional forms

The capital adjustment costs function \( \Gamma(.) \) is modeled following Jermann (1998),

\[ \Gamma(x) = \frac{\alpha_1}{1 - 1/\zeta_k} x^{1-1/\zeta_k} + \alpha_2 k \]  

(34)

and that the labor and goods supply equal their respective demands.
where \(\alpha_{1,k}\) and \(\alpha_{2,k}\) are determined such that there is no adjustment costs in the deterministic steady state. The debt adjustment cost is assumed to be quadratic,

\[
\psi(\tilde{b}_{t+1}, \tilde{b}_t) = \frac{\chi b}{2} \left( \tilde{b}_{t+1} - \tilde{b}_t \right)^2 \tilde{k}_{j,t}
\]

where \(\tilde{b}_{t+1}\) is corporate debt normalized by the average industry capital \(K_{j,t+1}\), and \(\chi_b\) is a parameter capturing the magnitude of the cost to change leverage. Note that this specification ensures that the debt adjustment cost has no impact on the deterministic steady state.

In a similar spirit as Chen (2010), I model the cost of bankruptcy \(\xi_t\) to be a function of the productivity process \(\Delta a_t\),

\[
\xi_t = \xi + \xi_1 \Delta \hat{a}_t
\]

where \(\Delta \hat{a}_t = \Delta a_t - \mu\). Finally, the firm specific shock \(z\) is assumed to follow a normal distribution with a mean of zero and a variance \(\sigma_z\).

### 4.2 Calibration

The model parameters are picked in two ways. First, standard real business cycles parameters as well as preference parameters are set to values from the existing literature. The remaining parameters are estimated by minimizing the distance between moments simulated from the model and empirical targets. All parameters values are summarized in Table 1.

The preference parameters are standard in the long-run risk literature (e.g. Croce (2014), Kung (2015)). The elasticity of intertemporal substitution \(\psi\) is set to 2 and the coefficient of relative risk aversion \(\gamma\) is set to 10. The subjective discount factor \(\beta\) is equal to 0.99.

The relative preference for labor, \(\varphi\), is set such that the household works 1/3 of her time endowment in the steady state. On the technology side, the capital share \(\alpha\) is set to 0.33, and the depreciation rate of capital \(\delta_k\) is set to 2.0% (e.g. Comin and Gertler (2006)). The productivity process is calibrated following Croce (2014). The persistence of the long run risk is set to imply a annual persistence of 0.85. The conditional annualized volatility of the short- and long-run productivity shocks are \(\sigma_a = 4.5\%\) and \(\sigma_x = 0.335\%\), respectively. The elasticity of substitution across industries \(\nu\) does not affect model dynamics much, I set it to 1.\(^{31}\) Finally, I set the quarterly coupon payment, \(C\) to 7%/4 to match the average coupon

\(^{31}\)Note that when \(\nu < 1\), industry goods are complements while when \(\nu > 1\), they are substitute. \(\nu = 1\) is
payment of my sample (see Table 7).

The remaining parameters, namely \( \Theta = [\sigma_z, \xi, \chi_b, \zeta_k, \tau, \mu, \alpha_1, \{h_j\}] \) \( j=1 \) are chosen to minimize the distance between a vector of identifying moments from the data and the same moments generated from model simulations. Mathematically, I obtain the parameter estimates by solving,

\[
\hat{\Theta} = \arg \min_{\Theta} \left[ \hat{m} - m(\Theta) \right]' \hat{W}^{-1} \left[ \hat{m} - m(\Theta) \right]
\]

where \( \hat{W} \) is a weighing matrix set to the identity matrix, \( \hat{m} \) is a vector of empirical moments, and \( m(\Theta) \) is the vector of model-implied moments obtained assuming a value of \( \Theta \) for the structural parameters.

To ensure a successful identification, the empirical targets need to be carefully chosen. Table 2 reports the estimated structural parameters along with the eight identifying model and empirical moments. All targets are at the aggregate level except for the profit margin, net of investment that is at the industry level. More specifically, I target a quarterly average default rate of 0.25% in order to match the Moody’s average annual default rate of 1% per year. In the model, default is triggered by the idiosyncratic shock, therefore this moment provides a good identification for \( \sigma_z \). To identify the parameters governing \( \xi_t \), namely \( \xi \), and \( \alpha_1 \), I follow Chen (2010) and target a mean recovery rate in default of 45%, a volatility of recovery rates of 10%, a correlation between recovery rates and default of -0.82, and a correlation between recovery rates and output growth of 0.58. I also target an average annualized credit spreads of 90bps which is the average spread between Baa and Aaa yields used in previous studies (e.g. Gourio (2013)). \( \tau \) captures the tax-benefits of debt, it is identified using the mean aggregate book-to-asset ratio, set to 0.40 (e.g. Gourio (2013)). Next, I obtain the capital adjustment cost curvature \( \zeta_k \) by targeting an investment to output volatility of 4.50 (Croce (2014)). The mean growth rate in productivity, \( \mu \) is chosen to generate an annualized growth rate of output of 1.80%. To obtain \( \chi_b \), I aim a standard deviation of book-leverage of 9% (Gourio (2013)).

The last parameters to identify are the degree of concentration in each industry, \( h_j \). To make the model close to the empirical section where I use quintiles sorted on competition, I assume the existence of \( N = 5 \) representative industries. I further assume that the intensity of the Cobb-Douglas case.

\[\text{Moments from the model are computed on a long sample simulation of 25,000 observations, with a burning period of 1,000 quarters.}\]

\[\text{Theoretically, the model can accommodate any number of industries } N. \text{ The cost of having more industries}\]
of competition $h_j^{-1}$ linearly increases between $h_1^{-1} = h_{low}^{-1}$ and $h_5^{-1} = h_{hig}^{-1}$. This leaves me with $h_{hig}$ and $h_{low}$ to estimate. Because $h_j$ is directly linked to measures of market power, I follow a measure similar to [Allayannis and Ihrig (2001)](#) that I adjust to take capital expenditures into account. Specifically, market power is defined as

$$
MPI_{j,t} = \frac{\text{Sales}_{j,t} + \Delta\text{Inventory}_{j,t} - \text{Costs}_{j,t} - \text{Investment}_{j,t}}{\text{Sales}_{j,t} + \Delta\text{Inventory}_{j,t}}
$$

(38)

where $\Delta\text{Inventory}_{j,t}$ is the change in inventory, $\text{Costs}_{j,t}$ is the sum of payroll, cost of material, and energy, and $j-t$ are industry-year subscripts. The data is obtained from the NBER-CES Manufacturing Industry Database. Each year, I sort industries into quintiles based on their lagged measure of concentration. I then compute the average $MPI_{j,t}$ in the highest and lowest concentration quintile each year and get the average of these series. The resulting two target moments are 0.299 and 0.263.

The SMM estimates are reported in Table 2. Overall, the estimation matches the target moments fairly well. The value for $\sigma_z$ is 0.97 and allows me to exactly match the average quarterly default rate of 0.25%. The estimate value for $\xi$ is estimated at 11.8%, which is in the range of estimates in [van Binsbergen, Graham, and Yang (2010)](#). The bankruptcy cost cyclicality parameter $\alpha_1$ replicates quite well key dynamics of recovery rates reported in [Chen (2010)](#). The tax benefits of debt, $\tau$, is about 13.76%. The degree of concentration across industries, $h_j$’s implies a demand elasticity for the firm’s product of 3.87 (4.37) for the low- (high-) competition quintile. The value for $\chi_b$ generates a relatively stable financial leverage as in the data, i.e. $\sigma(\tilde{b}) = 8.3\%$.

## 5 Quantitative results

This section quantitatively assesses the importance of competition as a determinant of the cross-section of asset prices. First, I examine how the model matches key macroeconomics and asset pricing moments at the aggregate level. This is important as most of the parameters are calibrated at the economy-wide level. Next, I disaggregate moments by industries. The objective is to evaluate whether differences in industry competition are sufficient to explain the cross-sectional differences we observe in the data. Finally, I generate additional empirical

is the increased in computing time. None of the results in this paper depends on the particular assumption for $N$. 

24
predictions on the relationship between credit spreads, competition and idiosyncratic volatility that I test empirically in the next section.

5.1 Aggregate moments

Table 3 reports key business cycle moments from the calibrated model and the associated data moments. The calibrated model generates an average investment-output ratio of 21%, in line with its 20% empirical counterpart. The output volatility and relative macro volatility are quite close to the data. The model also replicates the correlations across key business cycle variables, namely the procyclicality of consumption, labor, and stock returns. Also, the implied persistence in consumption and output growth is low, as in the data.

Figure 2 describes the model dynamics in response to a positive productivity shock by means of impulse response functions. An increase in productivity leads to sustained growth and persistently increases firms’ profits opportunities. Because the elasticity of substitution is greater than one, the substitution effect dominates so that positive productivity leads to an increase in firm valuation proxies, such as the market-to-book ratio (MB). Simultaneously, the excess return on the aggregate stock market rises ($r_e - r_f$). As the continuation value of companies increases, less firms find it optimal to declare bankruptcy leading to a fall in aggregate default and a persistent drop in credit spreads ($cs$). In the model, agents exhibit preference for early resolution of uncertainty and are therefore averse to the long-run risk generated by low-frequency variations in productivity growth. As a consequence, financial assets that co-move with the business cycle will command a risk premium.

Table 3 also reports some key asset pricing moments from simulations. The model generates a large equity risk premium of about 6.80% per annum, and produces substantial variations in excess returns. The annualized standard deviation of excess stock returns is about 9.27%. The strong demand for precautionary savings drives the risk-free rate down to 2.14%, somewhat higher than in the data. The volatility of the risk free rate is also low (1.18%). The model generates a sizable credit spreads of 89bps which exhibits substantial time-series variation. The standard deviation in the model is 24bps and about 42bps in the data. As in the data, credit spreads are counter-cyclical. In particular, the correlation between credit spread and GDP growth is -0.36 in the data and -0.44 in the model. The countercyclicality of credit spreads leads to a bond risk premium. In the model, the credit
spread premium is around 20bps, that is 22% of the total credit spread\footnote{Formally, the credit spreads premium is defined as the difference between the yield on a risky bond minus the yield of riskless security that pays the expected bond payoff.}. Although empirical estimates are quite noisy, the credit risk premium in the model is on the lower range of values reported in the literature. Two reasons can explain this. First there exists strong empirical evidence suggesting that other factors contribute to this spread such as taxation (e.g. Elton, Gruber, Agrawal, and Mann (2001)), or liquidity (e.g. Ericsson and Renault (2006), and Chen, Lesmond, and Wei (2007)). Second, the model abstracts from ingredients that have proved useful to generating a large credit risk premia. For instance, Gourio (2013) assume the existence of disaster risk, while Chen (2010) and Bhamra, Kuehn, and Strebulaev (2010) use long-term debt and time-varying uncertainty. In unreported results, I find that allowing for countercyclical idiosyncratic risk helps raise the credit risk premium to 30bps without changing any of the model implications.

Table 4 reports several key aggregate corporate financing moments. The model generates an annual market leverage of about 0.11 and a frequency of equity issuance of 0.10 (0.09 in the data). The unconditional probability of default is 0.25% per quarter as in the data. Also, and consistent with recent evidence by Jermann and Quadrini (2012) and Covas and Haan (2011), equity payout are pro-cyclical while debt repayment are countercyclical. For instance, the correlation between equity payout (debt repayment) and GDP is 0.55 (-0.59) in simulated data. Jermann and Quadrini (2012) reports a correlation with GDP of 0.45 and -0.70, respectively.

Overall, the model does a good job matching unconditional moments and key dynamics of both macro aggregates and asset prices. The next section investigates how competition affects these decisions by disaggregating moments at the industry-level.

### 5.2 Industry moments

In this section, I disaggregate the moments and impulse response functions per industry to study the effects of competition on the cross-section of asset prices. It is important to remember that the only difference across industries is a calibrated proxy for market power. Therefore all cross-sectional differences will be induced by heterogeneity in $h_j$'s.

Table 5 reports various model moments for the high- and low-competition quintile. In the model and in the data, more competitive industries are characterized by lower profit margin.
The intuition is that competition erodes profits, making a unit of asset less productive in a competitive industry. This result is consistent with previous empirical studies (e.g., MacKay and Phillips (2005)). Because competition erodes firm’s growth opportunities by creating a negative externality from rival’s actions, competitive firms have lower Book-to-Market ratio. The last two columns compare the difference between the high and low competition quintiles in the model and in the data. The profit margin (as measured by market power) is 3.60% higher in concentrated industries. Moreover, the cross-sectional difference in Book-to-Market ratio is 0.032 closely match its empirical counterpart of 0.040.

The model predicts that concentrated industries use more financial leverage. What happens is that more concentrated industries have higher firm valuation and enjoy a better buffer against idiosyncratic cash-flow shocks. This lowers the probability of default, and increases the expected tax benefits of debt making leverage more attractive. Also, because default is countercyclical, bonds issued by concentrated firms are safer. This further increases the market value of debt and the incentive to use leverage. In the model, market leverage is 2.30% lower in competitive industries. By comparison, summary statistics from my data sample reveal a similar pattern: market leverage is 1.4% lower in the lowest concentration quintile. These results accords with a recent study by Xu (2012) who documents a strong negative relationship between competition and leverage, using import penetration as an instrumental variable. Therefore, the model prediction that competition decreases financial leverage seems supported in the data.

Table 5 also reports several asset pricing moments. Equilibrium credit spreads are higher in competitive industries (119bps) than in concentrated industries (62bps). The magnitude of the difference in the model is 57bps, higher than its empirical counterpart of 25bps. There are at least two reasons that explains this larger difference. First, the data sample is biased towards larger firms. Valta (2012) shows that the spread on bank loans is twice as high for smaller firms. This would bring us much closer to the 57bps. Secondly, firms in the sample varies across many more dimensions that in the model. Therefore a univariate analysis may not capture well the cross-sectional difference in credit spreads. In the data section, I run panel regression to alleviate some of these later concerns.

The model generates substantial differences in equity risk across industries. The average

---

35 Market leverage is obtained as the ratio of the market value of debt divided by sum of the market values of equity and debt.
36 MacKay and Phillips (2005) also find that competition decreases book leverage by about 3.6%.
excess return is 7.20% in concentrated vs. 6.43% in competitive industries. This leads to a concentration premium of 0.76%. In the data, this premium is 2.54%, with a standard error of 1.30%. Therefore the difference between model premium and the data estimate is not different at the usual confidence level. The estimated CAPM beta is also higher in less competitive industries by 0.14 (vs. 0.21 in the data). A series of recent empirical studies are supportive of these predictions. For instance, Bustamante and Donangelo (2015) document a positive relationship between excess returns, CAPM betas, and measures of industry concentration.

To understand why the risk premium on equity is lower in competitive industries, it is useful to look at some impulse response functions. Figure 3 compares the response to a positive long-run productivity shock in the high- vs. low-competition industry. Firms in competitive industries face a more elastic demand curve and increase production more when productivity rises. At the industry level, supply gets higher and industry competition increases. This puts a downward pressure on the output price and makes dividends less procyclical in competitive industries. At the same time, firm values rise, and the conditional probability of default drops. Because competitive firms are closer to bankruptcy, the value of their default option falls relatively more. This further dampens the effect of productivity on equity value. Finally, firms in concentrated industries have higher financial leverage which renders cash flows even more procyclical. Taken together, these three forces make equity value in concentrated industries more sensitive to productivity shocks. Since investors are averse to long-run risks, this gives birth to a concentration premium.

In short, the model predicts that competition decreases leverage, increases credit spreads, and decreases the equity premium. These predictions are in line with earlier studies and matches the data quantitatively. This is quite surprising given that the only source of heterogeneity in the model is $h_j$.

5.3 Decomposing the concentration premium

The prior literature has largely focused on linking competition to the unlevered equity risk premia. This paper shows that competition also affects optimal capital structure and default. These two decisions in turn affect equity risk. To assess the contribution of leverage and default to the concentration premium, I decompose the premium into two components. The first component measures the effect of competition on equity risk that arises from industry rivals’ actions. It relates to how competition affects the firm’s assets in place and growth
options. This premium is positive because in competitive industries, competitors create a procyclical negative externality that acts as a hedge against aggregate shocks. The second component measures the contribution of leverage and default.37

To obtain this decomposition, I proceed in two steps. First, I compute the equity premium on a security that pays the same cash-flows as the benchmark firm, but has no debt nor options to default. More specifically, the value of that synthetic security is,

$$V_{j,t}^A = E_t \sum_{s=t}^{\infty} M_{t,s} [(1 - \tau) \Pi_{j,s} - I_{j,s} + \tau \delta_k k_{j,s}]$$

(39)

The difference in equity premium between the low- and high-competition quintile measures the rival’s externality effect. Next, the remainder of the concentration premium unexplained by cash-flows from real assets is attributed to the default and leverage effects.

Estimating these components for the benchmark calibration reveals that the rivals’ externality effect generates a premium of 15bps (see Table 5). In other words, about 80% of the concentration premium comes from the “levered” component of returns. This highlights the importance of accounting for leverage and default in explaining the interaction between equity returns and industry competition.

5.4 Idiosyncratic risk and corporate spreads

The importance of idiosyncratic volatility for credit spreads dates back to at least Merton (1974). In his paper corporate debt is modeled as a default-free bond minus a put option on the firm assets. A rise in firm volatility increases the value of the put option to default. This lowers the value of debt and leads to an increase in corporate spreads. This section investigates how competition can amplify debtholders’ exposure to idiosyncratic volatility shocks. To that end, the model is augmented to allow for time-varying volatility in the firm-specific shock $z_{j,t}$

$$\sigma_{z_{j,t}} = \rho_{\sigma_z} \sigma_{z_{j,t-1}} + \sigma_{\sigma_z} \epsilon_{\sigma,j,t}$$

(40)

where $\epsilon_{\sigma,j,t}$ are standard normal i.i.d. shocks.

As we saw earlier, firms in competitive industries operate on a lower profit margin. As such, an increase in idiosyncratic volatility is more likely to drive competitive firms to default. In

---

37I consider these two effects jointly because the probability of bankruptcy drives both the value of the default option and the cost of leverage and are therefore hard to disentangle.
Merton (1974) context, competitive firms are more likely to exercise their default put option. Therefore we expect that the effects of a persistent increases in $\sigma_{z_{j,t}}$ on debt value to be stronger for more competitive firms. Figure 4 presents the impulse response fuctions to an increase in idiosyncratic volatility. In response to the higher idiosyncratic risk, default rates and credit spreads increase. To alleviate the increase in risk, firms try to cut on debt but adjusting leverage is costly. This leads to a small, persistent decrease in debt-to-assets that is not sufficient to avoid the sharp increase in default probability. Importantly, while credit spreads in both industries rise, the reaction in competitive industries is larger by around 33%.

Testing this prediction empirically is challenging because idiosyncratic volatility shocks are not as easily identified as in the model. In the empirical section of the paper, I go around this problem by using proxies based on stock market prices.

6 Panel regression

In this section, I test two empirical implications of the model using a data set of publicly traded bonds: (i) credit spreads in competitive industries are higher, and (ii) shocks to idiosyncratic volatility are amplified in competitive industries.

6.1 Bond sample construction

Bond sample construction I obtain corporate bond prices from the National Association of Insurance Commissioners (NAIC) bond transaction file. The NAIC file records all public corporate bond transactions by life insurance companies, property and casualty insurance companies, and Health Maintenance Organizations (HMOs). The database starts in 1994 but the coverage of disposal transactions (e.g. sales) only begins in 1995, leaving a sample period of 1995 to 2012. While not exhaustive, the NAIC database represents a substantial portion of the corporate bond market. Schultz (2001) and Campbell and Taksler (2003) for instance note that insurance companies hold between one-third and 40% of issued corporate bonds. Bessembinder, Maxwell, and Venkataraman (2006) estimate that they represent a substantial proportion ($\approx 12.5\%$) of total bond trading volume.

The NAIC bond transactions table is linked to the Mergent Fixed Income Securities Database (FISD) to obtain bond specific information such as the maturity, coupon rate, etc.

---

38The idiosyncratic risk process is calibrated as follows; $\rho_{\sigma_z} = 0.6$, and $\sigma_{\sigma_z} = 4\%$ which implies an annualized standard deviation of idiosyncratic industry volatility of 10% (e.g. Campbell, Lettau, Malkiel, and Xu (2001)).
To be part of the sample, bonds must be issued by a U.S. firm and pay a fixed coupon. Following [Campbell and Taksler (2003)], I also eliminate bonds with special bond features such as put, call, exchangeable, asset backed, and convertible. I only keep bonds with an investment-grade rating because insurance companies are often forbidden to invest in speculative-grade bonds. The transaction data for these bonds are thus likely to be unrepresentative of the market. Following [Bessembinder, Kahle, Maxwell, and Xu (2009)], I eliminate transactions smaller than $100,000 or those that involve the bond issuer, i.e., transactions labelled as cancelled, corrected, cancelled, corrected, issuer, direct, called, conversion, exchanged, matured, put, redeemed, sinking fund, tax-free, exchange, or tendered. To eliminate potential data-entry errors, I also remove return reversals. A return reversal is defined as a return of more than 15% in magnitude immediately followed by a more than 15% return in the opposite direction. Besides I exclude observations with obvious data errors such as negative price or transaction dates occurring after maturity. In case there are several bond transactions in a day, the daily bond price is obtained by weighting each transaction price by its volume (in face value).

Reported price in the NAIC file are clean bond price and accrued interests are added to get the full settlement price (i.e., the bond dirty price). Yields are computed by equating the dirty price to the present value of cash-flows and yield spreads are defined in excess of the benchmark treasury at the date of transaction. To get the benchmark treasury, I match the bond duration to the zero-coupon Treasury yields curve from [Gürkaynak, Sack, and Wright (2007)], linearly interpolating if necessary. Treasury yields with a maturity lower than 1 year are obtained from the CRSP risk-free series. Matching duration instead of maturity provides a more robust benchmark as coupon payment can vary greatly across issuers. As a final check and following [Gilchrist and Zakrajšek (2011)], I truncate the yield spreads in the sample to be between 5bps and 3,500bps and restrict the bond remaining maturity to be below 30 years.

Issuers’ accounting information are from Compustat and are matched using the 6 digits issuer CUSIP. Stock prices information are obtained in a similar way from the CRSP file. To ensure that all information is included in asset prices, stock returns and bond yield spreads

---

39When an issue is rated by more than one agency at a given date, the average rating is computed, otherwise the last rating in date is used.
from July of year $t$ to June of year $t+1$ are matched with accounting information for fiscal year ending in year $t-1$, following Fama and French (1992). Monthly yield spread observations are constructed using the last transaction of the month. The sample consists of an unbalanced monthly panel of 12,198 different bond-month transactions. The final number of observations depends on the definition of competition.

**Industry competition measures** In the model, the degree of competition is captured by industry concentration. A direct empirical proxy is the sales-based Herfindahl-Hirschman index (HHI) published by the U.S. Census of Manufactures. I use this measure as my benchmark. More formally, the sales-based HHI is defined as follows,

$$\text{HHI}_j = \sum_{i=1}^{N_j} s^2_{i,j}$$

where $s_{i,j}$ is the sales market share of firm $i$ in industry $j$. The U.S. Census data is updated every five years and covers only manufacturing industries. Following Ali, Klasa, and Yeung (2009), I use the HHI for a given year, and assume this is also a good proxy for concentration for the one or two years immediately before and after it. An advantage of the U.S. Census data is that it covers both public and private firms and it has been shown in a prior literature that it is a good proxy for actual industry concentration (e.g. Ali, Klasa, and Yeung (2009)). Throughout the rest of the paper, I define an industry by using the 4-digit SIC industry classification.

To check the robustness of my results, I use several other well-used measures of competition. The first is a measure based on markup power used in Allayannis and Ihrig (2001):

$$\text{Market power}_{j,t} = \frac{\text{Sales}_{j,t} + \Delta\text{Inventory}_{j,t} - \text{Payroll}_{j,t} - \text{Cost of Material}_{j,t}}{\text{Sales}_{j,t} + \Delta\text{Inventory}_{j,t}}$$

The data are obtained at the industry level from the NBER-CES Manufacturing Industry Database. The second measure is the *Fitted SIC-based Industry concentration* data used in Hoberg and Phillips (2010). This fitted measure has the advantage of capturing the influence of both public and private firms, and to be available for all industries.40

---

40 Many thanks to the authors for making the data available on their website.
6.2 Descriptive statistics

In Table 6, I report the average yield and yield spread from my NAIC benchmark bond transactions sample, sorted on credit rating. To facilitate notation, I report credit rating using the Moody’s rating scale only. In the sample, the majority of bond transactions (≈ 79%) lies in the A-Baa categories, a pattern consistent with earlier studies (e.g. Campbell and Taksler (2003)). The average monthly spread between Baa and Aaa bonds is about 113 bps, close to the average spread reported by Moody’s over the same period (101 bps). In Figure 5, I plot the time series of the average Baa yield spread obtained from my NAIC sample along with the spreads reported by Moody’s over the same period. The two series follow a similar pattern with pikes occurring during the 2000’s and the financial crisis. The time series correlation between the two series is high (≈ 0.91). In Panel A of Table 7, I report summary statistic for my bond sample. The size of issue is positively skewed, with an average (median) debt issue of 541 (350) millions. The time-to-maturity of the bonds is long, about 10 years. The summary statistics are similar to those of previous studies using public debt (e.g. Gilchrist and Zakriješk (2011)). Panel B reports individual firm summary statistics. The average firm size in the sample is fairly large. This is consistent with previous empirical work that finds that firms issuing public debt are larger than firms using bank loans (e.g. Denis and Mihov (2003)). Finally, I report the average 4-digit SIC HHI by 2-digit SIC industries in Table 8. The resulting sort of industries is similar to that in Table 5 of Ali, Klasa, and Yeung (2009).

Overall these results suggest that my bond transaction sample is quite representative of the investment-grade bond market. My firm sample is biased towards the largest, safest firms. As a consequence, my empirical results should be a lower bound of the true effects of competition on credit spreads.

6.3 Concentration and the cross section of corporate yield spreads

This section investigates the first empirical prediction of the model, namely credit spreads in competitive industries are higher. Following the litterature I define competition as a dummy equal to one if HHI is in the lowest quintile of the yearly sample distribution and zero otherwise. This specification will facilitate the economic interpretation of the coefficient and also mitigate measurement errors.
Univariate analysis. I start my investigation by looking at univariate sorts on industry concentration. Table 9 reports the mean, and median bond yield spread for the highest and lowest competition quintile. Consistent with the model predictions, credit spreads in more competitive industries are higher by 25bps. The difference in mean and median are both statistically significant. Also and perhaps surprisingly, the estimate is quite close to the bank loan spread difference between low and high competition industry reported in Valta (2012) (22bps for large firms). Table 9 also reports the mean and median stock excess return across competition quintiles. Excess stock returns are lower in competitive industries (-2.54% for the mean and -3.29% for the median). These results are statistically significant and consistent with the model prediction that equity is safer in more competitive industries.

Multivariate analysis. Using my monthly panel data, I investigate whether measures of concentration have any predictive power on corporate yield spreads for public debt. In particular, I run the following regression model,

\[ cs_{i,t} = \delta \times \text{Comp}_{i,t-1} - 1 + \beta X_{i,t-1} + \epsilon_{i,t} \] (43)

where \((i,t)\) denotes a specific firm-month observation, \(\text{Comp}_{i,t-1}\) is equal to one if the firm is in the highest competition quintile and zero otherwise, and \(X_{i,t-1}\) is a vector of controls, potentially including time, or industry fixed effects. The parameter of interest is \(\delta\). It captures the difference in credit spreads for firms operating in competitive industries.

I group my set of controls into three categories: equity characteristics, bond characteristics, and macroeconomic variables. It is important to control for all these characteristics because, in contrast to the model, the bond data set exhibits vast heterogeneity in both bond and firm characteristics. In the equity controls category, I include the mean and volatility of the firm abnormal equity returns (net of the market return), for the 180 days prior to the month when the transaction occurs. I also control for leverage (total debt to capitalization), the firm size (log-asset) and asset tangibility (e.g. Ortiz-Molina and Phillips (2014)). I also add the log-book-to-market ratio and the log-market value of equity, two well-known determinants of the cross-section of equity returns.\(^{41}\)

---

\(^{41}\)Total debt to capitalization is \([\text{total long-term debt (DLTT) + debt in current liabilities (DLC) - cash holdings (CHE)}] / [\text{total liabilities (LT) + market value of equity (CRSP)}]\). The book-to-market ratio is defined as \([\text{book value of stockholders’ equity (CEQ), plus balance sheet deferred taxes (TXDITC) - book value of preferred stock (PST)}] / [\text{market equity (CRSP)}] at the end of June of the year following the fiscal year.
I also control for a series of bond specific characteristics. I include bond ratings to take into account the overall risk of the firm. Moody’s ratings are converted to numerical values by creating an index starting at 12 (Baa3) and linearly increasing by one for each credit rating notch. I control for the bond years-to-maturity because longer maturity bonds are likely to be riskier (e.g. Leland and Toft (1996)). I also include the coupon rate since bonds that pay higher coupon suffers from higher taxation (e.g. Elton, Gruber, Agrawal, and Mann (2001)). Corporate bonds exhibit various degree of trading frequency which can lead to the presence of an illiquidity premium (e.g. Ericsson and Renault (2006), and Dick-Nielsen, Feldhüttter, and Lando (2012)). To control for bond-specific illiquidity I include a measure of trading turnover defined as the average, over the past twelve months, of trading volume as a proportion of total amount outstanding. I also add the log amount outstanding because smaller issue are likely to be less liquid.

Finally, I include a series of macroeconomic variables to capture the level (3-month Treasury Bill), and the slope (10-year minus 1-year Treasury Bond yields) of the yield curve. I also use the 1-month Euro-Dollar spread as a proxy for aggregate demand for liquidity (e.g. Longstaff (2004)). I also include the 180-day moving average and standard deviation of the aggregate market return. Finally, I control for the aggregate labor share obtained from Bureau of Labor Statistics (Favilukis, Lin, and Zhao (2013)). In the regressions, bond yield spreads from July of year $t$ to June of year $t + 1$ are matched with accounting information for fiscal year ending in year $t − 1$. Equity and macroeconomic data are lagged one month. This ensures that all information is included in asset prices at the time the transaction takes place. Also all reported $t$-statistics are calculated using standard errors clustered at the industry level.

Table 10 reports the main regression results (see for Table 12 for the detailed regression output) estimated both from the NAIC bond transaction panel and from simulated model data. Columns (1) presents coefficient estimates without any controls. The coefficient of interest, $\delta$, is estimated to be around 23bps and is statistically significant. In other words, a firm operating in the highest competition quantile is expected to have its corporate debt discounted by about 23bps on financial markets. In column (2), I control for the firm idiosyncratic volatility. The point estimate slightly drops to 16bps and becomes marginally insignificant. Note that the regression fit raises from 1% to 16%, confirming that idiosyncratic volatility


Simulated panel are such that the total number of observations is equal to the data. For more details see the table description.

35
contains important information about credit spreads (e.g. Campbell and Taksler (2003)).

Columns (3)-(4) present the same regressions using simulated data from the calibrated model. As expected, the model overestimates the effects of competition on credit spreads. This is due to the fact that the empirical data set is biased towards the largest, safest firms. The coefficient estimates are 37bps and 36bps for the two regression specifications and are both statistically significant. The $R^2$ also increases following the inclusion of idiosyncratic volatility, although less than in the data. The last three columns present robustness checks. Column (5) checks whether these results are robust to the inclusion of the battery of controls defined earlier. I also add industry fixed effect. While $\delta$ slightly drops from 16bps to 15bps, it is strongly significant at the usual confidence level. Columns (6)-(7) presents results from the same model as column (5) but using alternative measures for competition and show that the model predictions are also robust across those dimensions. Note that the estimates are in line with findings in Valta (2012) who find that competitive firms pay about 15bps more on bank loans.

In short, this section shows that firms operating in more competitive industries have less valuable corporate debt. The value discount is estimated to be between 15bps and 24bps. In terms of cash flow, it means that firms facing tougher competition pay on average between USD811,500 and USD1,298,000 of additional interest payments on their debt, per year.\footnote{These values are obtained assuming a debt face value of $541M (the average face value in the sample).}

The magnitude is also comparable to the effect of a one- to three-notch downgrade in credit rating.

### 6.4 Competition, firm volatility and yield spreads

In the model, competitive firms are more sensitive to changes in idiosyncratic risk (e.g. see Figure 4). In this section, I test this prediction in the data. While shocks to firm-level volatility are well-identified in the model, they are quite challenging to identify in the data. To go around this problem, I use the 180-day moving standard deviation of abnormal excess returns as a proxy for $\sigma_{z,t}$. In particular, I run the following regression model,

$$
 cs_{i,t} = \delta_0 \times \sigma_{i,t-1}^{px} + \delta_1 \times \text{Comp}_{i,t-1} \times \sigma_{i,t-1}^{rx} + \beta X_{i,t-1} + \epsilon_{i,t}
$$

\hspace{1cm} (44)

where $(i, t)$ denotes a specific firm-month observation, $\text{Comp}_{i,t-1}$ is equal to one if the firm is in the highest competition quintile and zero otherwise, $\sigma_{i,t-1}^{rx}$ is a 180-day backward moving
average of the market-adjusted stock return volatility, and $X_{i,t-1}$ is a vector of controls, potentially including time, industry or firm fixed effects. The parameter of interest is the interaction coefficient $\delta_1$. It captures the extent to which competition increases the sensitivity of credit spreads to change in idiosyncratic risk.

Table 11 presents the main regression output. The full detailed panel is reported in Table 13. Column (1) reports the coefficient estimates without controls, except for industry fixed effects. The interaction term coefficient has the expected sign, companies in more competitive industries are more sensitive to change in firm-specific volatility. The coefficient falls short of statistical significance, which is not surprising given the degree of heterogeneity in bond and firm characteristics. Column (2) reports the coefficient estimates from model simulations. $\delta_1$ is estimated at around 13bps which is slightly lower than in the data (19bps). In column (3) I control for firm and bond characteristics and $\delta_1$ becomes significant while keeping the same magnitude of around 21bps. In economic terms, a 1% increase in idiosyncratic volatility increases corporate yield spreads by an additional 21bps in a more competitive industry. In terms of portfolio performance, a bond portfolio of debt issued by competitive firms lose an additional 1.49% return for each 1% increase in idiosyncratic volatility. These results stays economically and statistically significant, even after controlling for firm fixed effects in column (4), or using the alternative measures of competition in columns (5)-(6).

7 Conclusion

This paper develops a production-based asset pricing model to explore the effects of industry competition on the cross-section of credit spreads and levered equity returns. The model features two main sources of risks: aggregate and idiosyncratic. In equilibrium, competition affects asset prices by affecting the firm exposure to these risks. First, the competitive externality channel creates an externality from peers’ actions that makes the firm cash flows less procyclical. This effect reduces firm risk. Second, competition increases the firm exposure to idiosyncratic risk and leads to a default option effect. This further reduces the risk of equity and leads corporate debt to be both less valuable and riskier. As a result of their competitive disadvantage in issuing debt, firms in competitive industries substitute equity for debt.

\[44\] I also include in the controls the $\text{Comp}_{i,t-1}$ dummy.

\[45\] These calculations are obtained by computing the realized return on a bond whose characteristics are set to the sample average and assuming a 1% increase in idiosyncratic volatility.
Ultimately, competitive firms issue less, but more expensive debt.

The model is calibrated to match a set of aggregate moments and to replicate cross-sectional differences in market power across concentration quintiles. Because the only difference across industries is the intensity of competition, the model offers a compelling laboratory to quantify the importance of product market structure. I find that competition has large effects on corporate decisions and asset prices. The magnitudes across competition quintiles for equity returns and financial leverage accords with the existing empirical literature. I verify additional predictions using a panel of publicly traded corporate bond transactions and find that product market competition increases average credit spreads by 15bps. Also, credit spreads in more competitive industries are 40% more sensitive to idiosyncratic risk. These results are robust to the inclusions of various controls and alternative measures of competition.
References


Bustamante, Maria Cecilia, and Andres Donangelo, 2015, Industry concentration and markup: Implications for asset pricing, *University of Maryland, and University of Texas at Austin Working Paper*.


Elkamhi, Redouane, Jan Ericsson, and Min Jiang, 2011, Time-varying asset volatility and the credit spread puzzle, *University of Toronto, McGill University, and University of Iowa Working Paper*. 

41


Favilukis, Jack, Xiaoji Lin, and Xiaofei Zhao, 2013, The elephant in the room: the impact of labor obligations on credit risk, *University of British Columbia, Ohio State University, and University of Texas at Dallas Working Paper*.

Frésard, Laurent, and Philip Valta, 2014, How does corporate investment respond to increased entry threat?, *University of Maryland, and Swiss Finance Institute Working Paper*.


Table 1: Quarterly Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Preference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>β</td>
<td>Subjective discount factor</td>
<td>0.99</td>
</tr>
<tr>
<td>ψ</td>
<td>Elasticity of intertemporal substitution</td>
<td>2.00</td>
</tr>
<tr>
<td>γ</td>
<td>Risk aversion</td>
<td>10.00</td>
</tr>
<tr>
<td>B. Production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>α</td>
<td>Capital share</td>
<td>0.33</td>
</tr>
<tr>
<td>δₖ</td>
<td>Depreciation rate of capital stock</td>
<td>2.00%</td>
</tr>
<tr>
<td>ζₖ</td>
<td>Capital adjustment cost parameter</td>
<td>10.54↑</td>
</tr>
<tr>
<td>C. Productivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4μ</td>
<td>Mean of ∆ₘ</td>
<td>1.72%↑</td>
</tr>
<tr>
<td>ρ₄</td>
<td>Persistence of ∆ₘ</td>
<td>0.85</td>
</tr>
<tr>
<td>√4σₘ</td>
<td>Conditional volatility of</td>
<td>4.50%</td>
</tr>
<tr>
<td>√₄σ₊</td>
<td>Conditional volatility of</td>
<td>0.34%</td>
</tr>
<tr>
<td>D. Finance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Coupon payment</td>
<td>7%/4</td>
</tr>
<tr>
<td>ξ₀</td>
<td>Bankruptcy costs</td>
<td>11.81%↑</td>
</tr>
<tr>
<td>ξ₁</td>
<td>Bankruptcy costs cyclicality</td>
<td>-10.89↑</td>
</tr>
<tr>
<td>σₓ</td>
<td>Volatility idiosyncratic shock</td>
<td>0.97↑</td>
</tr>
<tr>
<td>τ</td>
<td>Corporate tax rate</td>
<td>13.76%↑</td>
</tr>
<tr>
<td>χₜ</td>
<td>Debt adjustment cost parameter</td>
<td>0.28↑</td>
</tr>
<tr>
<td>E. Industry parameters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ν</td>
<td>Elasticity of substitution across industries</td>
<td>1</td>
</tr>
<tr>
<td>ℎₗₜₜ</td>
<td>Elast. of subst. in low concentr. industry</td>
<td>0.2287↑</td>
</tr>
<tr>
<td>ℎₗₜₜ</td>
<td>Elast. of subst. in high concentr. industry</td>
<td>0.2583↑</td>
</tr>
</tbody>
</table>

Table 1: Benchmark quarterly calibration. This table reports the parameter values used in the benchmark quarterly calibration of the model. ↑ denotes a parameter estimated by SMM.
Table 2: Simulated methods of moments estimates

<table>
<thead>
<tr>
<th>Target moment</th>
<th>Data</th>
<th>Model</th>
<th>Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarterly default rate</td>
<td>0.25%</td>
<td>0.25%</td>
<td>$\sigma_z = 0.9685$</td>
</tr>
<tr>
<td>Baa-Aaa yields spread</td>
<td>90bps</td>
<td>89bps</td>
<td>$\xi = 11.812%$</td>
</tr>
<tr>
<td>Average bond recovery</td>
<td>0.40</td>
<td>0.41</td>
<td>$\xi_1 = -10.89$</td>
</tr>
<tr>
<td>Volatility bond recovery</td>
<td>0.10</td>
<td>0.21</td>
<td></td>
</tr>
<tr>
<td>Corr(Bond recovery,Default)</td>
<td>-0.82</td>
<td>-0.52</td>
<td></td>
</tr>
<tr>
<td>Corr(Bond recovery,Profit growth)</td>
<td>0.58</td>
<td>0.96</td>
<td></td>
</tr>
<tr>
<td>Book leverage</td>
<td>0.40</td>
<td>0.35</td>
<td>$\tau = 13.76%$</td>
</tr>
<tr>
<td>Standard deviation book leverage</td>
<td>0.09</td>
<td>0.08</td>
<td>$\chi_b = 0.2816$</td>
</tr>
<tr>
<td>Investment-to-output vol.</td>
<td>4.50</td>
<td>5.99</td>
<td>$\zeta_k = 10.544$</td>
</tr>
<tr>
<td>Mean growth rate of output</td>
<td>1.80%</td>
<td>1.85%</td>
<td>$\mu = 0.430%$</td>
</tr>
<tr>
<td>Profit margin high concentration</td>
<td>0.299</td>
<td>0.299</td>
<td>$h_{hi} = 0.2583$</td>
</tr>
<tr>
<td>Profit margin low concentration</td>
<td>0.263</td>
<td>0.263</td>
<td>$h_{lo} = 0.2287$</td>
</tr>
</tbody>
</table>

Table 2 SMM estimates and empirical targets. This table reports the empirical targets, model moments, and corresponding parameters estimates obtained from the simulated method of moments procedure.

Table 3: Aggregate business cycle and asset pricing moments

<table>
<thead>
<tr>
<th>Moment</th>
<th>Data</th>
<th>Model</th>
<th>Moment</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Business cycle</strong></td>
<td></td>
<td></td>
<td><strong>B. Asset prices</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$E(\Delta y)$</td>
<td>1.80</td>
<td>1.85†</td>
<td>$corr(\Delta c, \Delta y)$</td>
<td>0.39</td>
<td>0.82</td>
</tr>
<tr>
<td>$E(I/Y)$</td>
<td>0.20</td>
<td>0.21</td>
<td>$corr(\Delta l, \Delta y)$</td>
<td>0.75</td>
<td>0.53</td>
</tr>
<tr>
<td>$\sigma(\Delta y)$</td>
<td>3.56</td>
<td>3.44</td>
<td>$corr(\Delta c, r_e - r_f)$</td>
<td>0.25</td>
<td>0.82</td>
</tr>
<tr>
<td>$\sigma_{\Delta e}/\sigma_{\Delta y}$</td>
<td>0.71</td>
<td>0.85</td>
<td>$ACF_1(\Delta y)$</td>
<td>0.35</td>
<td>0.10</td>
</tr>
<tr>
<td>$\sigma_{\Delta l}/\sigma_{\Delta y}$</td>
<td>4.50</td>
<td>5.99†</td>
<td>$ACF_1(\Delta c)$</td>
<td>0.32</td>
<td>0.13</td>
</tr>
<tr>
<td>$\sigma_{\Delta l}$</td>
<td>1.70%</td>
<td>1.31%</td>
<td>$ACF_1(i - k)$</td>
<td>0.86</td>
<td>0.89</td>
</tr>
<tr>
<td>$E(r_e - r_f)$</td>
<td>7.23</td>
<td>6.80</td>
<td>$\sigma(r_e - r_f)$</td>
<td>16.54</td>
<td>9.27</td>
</tr>
<tr>
<td>$E(r_f)$</td>
<td>1.51</td>
<td>2.14</td>
<td>$\sigma(r_f)$</td>
<td>2.25</td>
<td>1.18</td>
</tr>
<tr>
<td>$E(cs_t)$</td>
<td>90bps</td>
<td>89bps†</td>
<td>$\sigma(cs_t)$</td>
<td>42bps</td>
<td>24bps</td>
</tr>
</tbody>
</table>

Table 3 Aggregate Macro and Asset Pricing moments. This table reports aggregate macroeconomics and asset pricing moments from the model and the data. $\Delta y$, $\Delta c$, $\Delta l$, $\Delta i$ denotes output growth, consumption growth, labor growth, and investment growth respectively. $I/Y$ is investment over GDP, $i - k$ is the log investment-to-capital ratio, $r_e - r_f$ is the aggregate stock market excess return, $r_f$ is the one-period real risk-free rate, and $cs_t$ is the aggregate credit spread. Model moments are calculated by simulating the model for 25,000 quarters, with a 1,000 quarters burning period. Aggregate quantities are obtained by summing up industry-level data, aggregate returns and credit spreads are equally-weighted. Growth rates, and returns moments are annualized percentage, credit spreads are in annualized basis point units. † denotes a SMM target moment.
### Table 4: Aggregate financing moments

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market leverage</td>
<td>0.18</td>
<td>0.11</td>
</tr>
<tr>
<td>Frequency of equity issuance</td>
<td>0.09</td>
<td>0.10</td>
</tr>
<tr>
<td>Default rate</td>
<td>0.25%</td>
<td>0.25%†</td>
</tr>
<tr>
<td>corr(Equitypay,GDP)</td>
<td>0.45</td>
<td>0.55</td>
</tr>
<tr>
<td>corr(DebtRep,GDP)</td>
<td>-0.70</td>
<td>-0.59</td>
</tr>
<tr>
<td>corr(cs,Δy)</td>
<td>-0.36</td>
<td>-0.44</td>
</tr>
</tbody>
</table>

**Table 4** Aggregate financing moments. This table reports aggregate financing moments from the model and from the data. Debt repayment (DebtRep) and Equity payout (Equitypay) are normalized by output. Data moments are obtained from Jermann and Quadrini (2012) and Chen, Collin-Dufresne, and Goldstein (2009). Model moments are calculated by simulating the model for 25,000 quarters, with a 1,000 quarters burning period. The data are aggregated by summing up industry-level data. Growth rates, and returns moments are annualized percentage, credit spreads are in annualized basis point units. † denotes a SMM target moment.

### Table 5: Industry variables

<table>
<thead>
<tr>
<th></th>
<th>Simulated moments</th>
<th>High minus Low</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High comp.</td>
<td>Low comp.</td>
</tr>
<tr>
<td>Market power</td>
<td>0.263†</td>
<td>0.299†</td>
</tr>
<tr>
<td>Book-to-Market</td>
<td>0.377</td>
<td>0.345</td>
</tr>
<tr>
<td>Market Leverage</td>
<td>0.100</td>
<td>0.124</td>
</tr>
<tr>
<td>Default rate</td>
<td>0.35%</td>
<td>0.15%</td>
</tr>
<tr>
<td>$E(cs)$</td>
<td>119bps</td>
<td>62bps</td>
</tr>
<tr>
<td>$E(r_i - r_f)$</td>
<td>6.43%</td>
<td>7.20%</td>
</tr>
<tr>
<td>$β_{CAPM}$</td>
<td>0.93</td>
<td>1.07</td>
</tr>
<tr>
<td>$E(r_A^i - r_f)$</td>
<td>3.73%</td>
<td>3.88%</td>
</tr>
</tbody>
</table>

**Table 5** Industry moments. This table reports several key moments sorted by competition quintiles. Model moments are calculated by simulating the model for 25,000 quarters, with a 1,000 quarters burning period. The data are then aggregated by competition quintiles. Data moments are obtained as follows: market power is calculated following Eq. 38; excess returns, market leverage, and credit spreads moments are obtained from my panel data set where competition is defined as the U.S. Census 4-digit SIC HHI; CAPM beta, and Book-to-Market are from Bustamante and Donangelo (2015). Market leverage is obtained as the ratio of the market value of debt divided by sum of the market values of equity and debt. The market value of debt is defined as total debt times the market value of 1$ of debt obtained from my data sample. $r_i - r_f$ is the return on equity in excess of the risk-free rate, $r_A^i - r_f$ is the excess return on a security that receives the same operating cash flows as the benchmark firm with no idiosyncratic risk nor debt (see Eq. 39). † denotes a SMM target moment.
Table 6: Yield data per rating category

<table>
<thead>
<tr>
<th>Rating</th>
<th>Yield</th>
<th>Yield Spread</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaa</td>
<td>5.31</td>
<td>64.72</td>
<td>304</td>
</tr>
<tr>
<td>Aa</td>
<td>5.17</td>
<td>74.61</td>
<td>716</td>
</tr>
<tr>
<td>A</td>
<td>5.87</td>
<td>123.63</td>
<td>1958</td>
</tr>
<tr>
<td>Baa</td>
<td>6.44</td>
<td>198.05</td>
<td>1842</td>
</tr>
</tbody>
</table>

Table 6: Yield data per rating category. This table presents the sample average of corporate yields and yield spreads by credit rating for the benchmark data set (Manufacturing Census HHI measure). The yield spread is obtained by subtracting from the corporate spread, a Treasury yield with equal duration. The sample period of the NAIC data is from 1995 and 2012. Yields are in percent and yield spreads are in basis points. All bonds are in U.S. dollars and have no special features (call, put, convertibility, etc.).

Table 7: Summary statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Bond characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield (%)</td>
<td>5.95</td>
<td>6.20</td>
<td>1.70</td>
<td>0.38</td>
<td>15.72</td>
</tr>
<tr>
<td>Yield spread (bps)</td>
<td>141</td>
<td>110</td>
<td>113</td>
<td>6</td>
<td>1,276</td>
</tr>
<tr>
<td>Coupon (%)</td>
<td>7.00</td>
<td>6.99</td>
<td>1.23</td>
<td>2.13</td>
<td>12.63</td>
</tr>
<tr>
<td>Time to maturity (years)</td>
<td>9.78</td>
<td>7.30</td>
<td>7.62</td>
<td>0.01</td>
<td>29.98</td>
</tr>
<tr>
<td>Issue size (Millions)</td>
<td>541</td>
<td>350</td>
<td>604</td>
<td>25</td>
<td>4,800</td>
</tr>
<tr>
<td>Credit rating</td>
<td>A</td>
<td>A</td>
<td>-</td>
<td>Baa</td>
<td>Aaa</td>
</tr>
<tr>
<td>B. Firm characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Census HHI (log)</td>
<td>5.13</td>
<td>5.16</td>
<td>1.05</td>
<td>1.24</td>
<td>7.07</td>
</tr>
<tr>
<td>Asset size (log Millions)</td>
<td>9.21</td>
<td>9.19</td>
<td>1.12</td>
<td>6.33</td>
<td>12.27</td>
</tr>
<tr>
<td>Long-term debt to asset</td>
<td>0.22</td>
<td>0.21</td>
<td>0.11</td>
<td>0.02</td>
<td>0.91</td>
</tr>
<tr>
<td>Book-to-Market</td>
<td>0.40</td>
<td>0.34</td>
<td>0.32</td>
<td>-0.04</td>
<td>2.35</td>
</tr>
</tbody>
</table>

Table 7: Summary statistics. This table reports summary statistics for the benchmark sample. Panel A reports bond characteristics. Yield spreads are defined as the bond yield in excess a government bond with equal duration, coupon is the annualized coupon rate, Time to maturity is the difference between the maturity of the bond and the transaction date, the issue size is the total principal issued for a bond. Panel B reports firm characteristics, Census HHI is the U.S. Census Herfindhal Index computed at the 4-digit SIC industry level using the same methodology as Ali, Klasa, and Yeung (2009). Asset size is defined as total assets in Compustat, Long-term debt to asset is obtained from Compustat, the Book-to-Market ratio is defined as the ratio of book equity to the market value of equity. The variable units are detailed in the first column.
### Table 8: List of industries by concentration

<table>
<thead>
<tr>
<th>SIC</th>
<th>HHI</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>13.23</td>
<td>Lumber and wood products</td>
</tr>
<tr>
<td>34</td>
<td>46.20</td>
<td>Fabricated metal products</td>
</tr>
<tr>
<td>35</td>
<td>139.11</td>
<td>Industrial and commercial machinery and computer equipment</td>
</tr>
<tr>
<td>25</td>
<td>172.17</td>
<td>Furniture and fixtures</td>
</tr>
<tr>
<td>26</td>
<td>182.94</td>
<td>Paper and allied products</td>
</tr>
<tr>
<td>28</td>
<td>224.81</td>
<td>Chemicals and allied products</td>
</tr>
<tr>
<td>36</td>
<td>234.47</td>
<td>Electronic, electrical equipment</td>
</tr>
<tr>
<td>38</td>
<td>235.04</td>
<td>Measuring instruments</td>
</tr>
<tr>
<td>29</td>
<td>335.99</td>
<td>Petroleum refining</td>
</tr>
<tr>
<td>20</td>
<td>344.65</td>
<td>Food and kindred products</td>
</tr>
<tr>
<td>30</td>
<td>540.61</td>
<td>Rubber and plastic products</td>
</tr>
<tr>
<td>37</td>
<td>607.97</td>
<td>Transportation equipment</td>
</tr>
<tr>
<td>33</td>
<td>790.06</td>
<td>Primary metal industries</td>
</tr>
<tr>
<td>21</td>
<td>806.12</td>
<td>Tobacco products</td>
</tr>
<tr>
<td>32</td>
<td>891.21</td>
<td>Stone, clay, glass, and concrete products</td>
</tr>
</tbody>
</table>

Table 8 SIC2 industries and concentration. This table reports the average values of HHI-Census for 4-digit SIC industries within a 2-digit SIC industry. 4-digit SIC industries HHI are calculated by weighting the HHI-Census values of component 6-digit NAICS industries by the square of their share of the broader 4-digit SIC industry as in Ali, Klasa, and Yeung (2009).

### Table 9: Univariate analysis

<table>
<thead>
<tr>
<th></th>
<th>High Competition</th>
<th>Low Competition</th>
<th>Test of differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>Mean</td>
</tr>
<tr>
<td>Yield spread</td>
<td>163 bps</td>
<td>123 bps</td>
<td>138 bps</td>
</tr>
<tr>
<td>$E[r_i - r_f]$</td>
<td>8.59%</td>
<td>10.09%</td>
<td>11.14%</td>
</tr>
</tbody>
</table>

Table 9: Univariate analysis. This table reports the means and medians aggregated across all firms/months for subsamples of the data sorted on the U.S. Census 4-digit HHI concentration measure. The High Competition corresponds to the lowest concentration quintile and Low Competition to the highest concentration quintile. The yield spread is defined as the bond yield in excess of a government bond with equal duration and $r_i - r_f$ is the annualized realized stock return over the following year in excess of the daily bill. The last two columns of the table present test statistics of the t-test and the Wilcoxon test of the differences in mean and median across the two samples. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.
Table 10: Competition and the cross-section of yield spreads

<table>
<thead>
<tr>
<th>HHI</th>
<th>Model</th>
<th>HHI</th>
<th>Fit HHI</th>
<th>Markup</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>Competition</td>
<td>22.75*</td>
<td>16.17</td>
<td>37.39***</td>
<td>36.34***</td>
</tr>
<tr>
<td></td>
<td>(1.86)</td>
<td>(1.58)</td>
<td>(9.39)</td>
<td>(9.52)</td>
</tr>
<tr>
<td>Volatility excess return</td>
<td>57.93***</td>
<td>33.12***</td>
<td>56.98***</td>
<td>60.75***</td>
</tr>
<tr>
<td></td>
<td>(10.35)</td>
<td>(6.15)</td>
<td>(6.09)</td>
<td>(3.56)</td>
</tr>
<tr>
<td>Controls</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>4814</td>
<td>4814</td>
<td>5000</td>
<td>5000</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.01</td>
<td>0.16</td>
<td>0.13</td>
<td>0.15</td>
</tr>
<tr>
<td>Industry FE</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 10 Competition and the cross-section of credit spreads. This table presents point estimates from the panel regressions examining the effects of competition on industry credit spreads. Columns 1-2 and 5 are estimated using the U.S. Census HHI index at the 4-digit SIC level. Columns 3-4 are estimated from simulated model data across 5 industries, with a time series length such that the total number of observations in the panel is 5,000. Columns 6 and 7 presents robustness checks using Fit HHI from Hoberg and Phillips (2010) and the empirical measure of markup in Eq. 42, respectively. Product market competition is measured as a dummy equal to 1 if the firm is in the lowest quintile of concentration or market power measures in the year previous to the transaction date. All control variables are lagged by one month for monthly variables and 12 months for yearly variables. The volatility of excess return is calculated as the moving standard deviation of the individual stock return in excess of the market return over the past 180 days. Idiosyncratic volatility in the model is measured by $\sigma_{z,t}$ (see Eq. 40). Definitions of the variables included in the controls category is detailed in the sample description. Twelve month dummies are included in the regressions to control for any unobserved monthly time effects, and were omitted from the table. The detailed coefficient estimates are reported in Table 12. I report t-statistics calculated over standard errors clustered at the 48 Fama-French industries level in parentheses below the coefficient estimates. Significance at the 10%, 5%, and 1% level is indicated by *, **, and ***, respectively.
<table>
<thead>
<tr>
<th></th>
<th>HHI (1)</th>
<th>Model (2)</th>
<th>HHI (3)</th>
<th>Fit HHI (4)</th>
<th>Markup (5)</th>
<th>Markup (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competition × Ex. ret. volatility</td>
<td>18.90</td>
<td>12.81*</td>
<td>21.39***</td>
<td>21.26***</td>
<td>46.85*</td>
<td>16.76*</td>
</tr>
<tr>
<td></td>
<td>(1.21)</td>
<td>(1.83)</td>
<td>(3.28)</td>
<td>(2.74)</td>
<td>(1.79)</td>
<td>(1.86)</td>
</tr>
<tr>
<td>Volatility excess return</td>
<td>50.32***</td>
<td>29.15***</td>
<td>50.88***</td>
<td>39.95***</td>
<td>43.06***</td>
<td>48.24***</td>
</tr>
<tr>
<td></td>
<td>(6.28)</td>
<td>(5.65)</td>
<td>(5.34)</td>
<td>(5.96)</td>
<td>(5.88)</td>
<td>(4.07)</td>
</tr>
<tr>
<td>Controls</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>4814</td>
<td>5000</td>
<td>4814</td>
<td>4814</td>
<td>10004</td>
<td>4534</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.24</td>
<td>0.87</td>
<td>0.56</td>
<td>0.64</td>
<td>0.45</td>
<td>0.58</td>
</tr>
<tr>
<td>Industry FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Firm FE</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

**Table 11: Firm-risk, Competition and the cross-section of yield spreads.** This table presents point estimates from the panel regressions examining how competition amplifies the effects of firm-specific risk on credit spreads. Columns 1 and 3-4 are estimated using the U.S. Census HHI index at the 4-digit SIC level. Column 2 is estimated from simulated model data across 5 industries, with a time series length such that the total number of observations in the panel is 5,000. Columns 5-6 presents robustness checks using Fit HHI from Hoberg and Phillips (2010) and the empirical measure of markup in Eq. 42. Product market competition is measured as a dummy equal to 1 if the firm is in the lowest quintile of concentration or market power measures in the year previous to the transaction date. All control variables are lagged by one month for monthly variables and 12 months for yearly variables. The volatility of excess return is calculated as the moving standard deviation of the individual stock return in excess of the market return over the past 180 days. Idiosyncratic volatility in the model is measured by $\sigma_{z,t}$ (see Eq. 40). Definitions of the variables included in the different control categories is detailed in the sample description. Comp. × Ex. ret. volatility is the interaction term between the competition dummy and excess return volatility. A dummy for competition is also included in the regression but omitted from the table. Definitions of the variables included in the controls category is detailed in the sample description. Twelve month dummies are included in the regressions and omitted from the table. The detailed coefficient estimates are reported in Table 13. I report t-statistics calculated over standard errors clustered at the 48 Fama-French industries level in parentheses below the coefficient estimates. Significance at the 10%, 5%, and 1% level is indicated by *, **, and ***, respectively.
<table>
<thead>
<tr>
<th></th>
<th>Census HHI (1)</th>
<th>Census HHI (2)</th>
<th>Census HHI (3)</th>
<th>Census HHI (4)</th>
<th>Fit HHI (4)</th>
<th>Markup (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competition</td>
<td>22.75*</td>
<td>16.17</td>
<td>15.35***</td>
<td>17.77***</td>
<td>23.56***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.86)</td>
<td>(1.58)</td>
<td>(2.63)</td>
<td>(3.41)</td>
<td>(3.32)</td>
<td></td>
</tr>
<tr>
<td><strong>Equity characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatility excess return</td>
<td>57.93***</td>
<td>56.98***</td>
<td>60.75***</td>
<td>52.24***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(10.35)</td>
<td>(6.09)</td>
<td>(3.56)</td>
<td>(4.89)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean excess return</td>
<td>-50.41***</td>
<td>-98.26***</td>
<td>-61.11***</td>
<td>-141.52**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-3.83)</td>
<td>(-4.80)</td>
<td>(-4.94)</td>
<td>(-4.94)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total debt to capitalization</td>
<td>-144.31**</td>
<td>56.59</td>
<td>-141.52**</td>
<td>-141.52**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-2.57)</td>
<td>(0.78)</td>
<td>(-2.23)</td>
<td>(-2.23)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset (log)</td>
<td>46.05***</td>
<td>19.93</td>
<td>39.48**</td>
<td></td>
<td>39.48**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.34)</td>
<td>(1.48)</td>
<td>(2.76)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tangibility</td>
<td>27.77</td>
<td>-30.31</td>
<td>20.92</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.08)</td>
<td>(-1.19)</td>
<td>(0.77)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Book-to-market (log)</td>
<td>7.83</td>
<td>21.87</td>
<td>17.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.44)</td>
<td>(0.61)</td>
<td>(1.63)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size (log)</td>
<td>-43.76***</td>
<td>-25.63*</td>
<td>-40.49**</td>
<td>-25.63*</td>
<td>-40.49**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-3.27)</td>
<td>(-1.97)</td>
<td>(-2.52)</td>
<td>(-1.97)</td>
<td>(-2.52)</td>
<td></td>
</tr>
<tr>
<td><strong>Bond characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credit rating</td>
<td>-10.00***</td>
<td>-4.85**</td>
<td>-7.22***</td>
<td>-4.85**</td>
<td>-7.22***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-4.06)</td>
<td>(-2.41)</td>
<td>(-2.89)</td>
<td>(-2.41)</td>
<td>(-2.89)</td>
<td></td>
</tr>
<tr>
<td>Years to maturity</td>
<td>1.73***</td>
<td>1.86***</td>
<td>1.85***</td>
<td></td>
<td>1.85***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.30)</td>
<td>(8.91)</td>
<td>(5.31)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coupon rate (in %)</td>
<td>13.41***</td>
<td>6.93**</td>
<td>10.10***</td>
<td></td>
<td>10.10***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.60)</td>
<td>(2.71)</td>
<td>(5.21)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Issue size (log)</td>
<td>-9.39***</td>
<td>-3.48</td>
<td>-10.93**</td>
<td>-3.48</td>
<td>-10.93**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-2.22)</td>
<td>(-0.95)</td>
<td>(-2.45)</td>
<td>(-0.95)</td>
<td>(-2.45)</td>
<td></td>
</tr>
<tr>
<td>Trading turnover</td>
<td>-65.22**</td>
<td>-51.19***</td>
<td>-47.94**</td>
<td>-51.19***</td>
<td>-47.94**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-2.56)</td>
<td>(-3.82)</td>
<td>(-2.81)</td>
<td>(-3.82)</td>
<td>(-2.81)</td>
<td></td>
</tr>
<tr>
<td><strong>Macroeconomic variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3m T-Bill (in %)</td>
<td>-17.84***</td>
<td>-20.92***</td>
<td>-17.05***</td>
<td>-20.92***</td>
<td>-17.05***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-6.13)</td>
<td>(-6.21)</td>
<td>(-3.76)</td>
<td>(-6.21)</td>
<td>(-3.76)</td>
<td></td>
</tr>
<tr>
<td>Term spread (in %)</td>
<td>-7.82</td>
<td>-13.81***</td>
<td>-7.62</td>
<td>-13.81***</td>
<td>-7.62</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-1.60)</td>
<td>(-2.77)</td>
<td>(-1.20)</td>
<td>(-2.77)</td>
<td>(-1.20)</td>
<td></td>
</tr>
<tr>
<td>1m Eurodollar spread (in %)</td>
<td>27.18***</td>
<td>13.66*</td>
<td>24.14***</td>
<td>13.66*</td>
<td>24.14***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8.54)</td>
<td>(2.01)</td>
<td>(8.52)</td>
<td>(2.01)</td>
<td>(8.52)</td>
<td></td>
</tr>
<tr>
<td>Labor share</td>
<td>-4.18**</td>
<td>2.24</td>
<td>-4.03***</td>
<td></td>
<td>-4.03***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-2.12)</td>
<td>(1.22)</td>
<td>(-3.00)</td>
<td>(1.22)</td>
<td>(-3.00)</td>
<td></td>
</tr>
<tr>
<td>Vol. of daily index ret. (in %)</td>
<td>11.36</td>
<td>-32.39</td>
<td>9.45</td>
<td>-32.39</td>
<td>9.45</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.97)</td>
<td>(-1.63)</td>
<td>(0.73)</td>
<td>(-1.63)</td>
<td>(0.73)</td>
<td></td>
</tr>
<tr>
<td>Mean daily index ret. (in %)</td>
<td>-248.05***</td>
<td>-324.49***</td>
<td>-234.40***</td>
<td>-324.49***</td>
<td>-234.40***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-4.50)</td>
<td>(-7.03)</td>
<td>(-5.20)</td>
<td>(-7.03)</td>
<td>(-5.20)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>130.00***</td>
<td>27.53**</td>
<td>1069.70***</td>
<td>229.84</td>
<td>1061.55***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(9.81)</td>
<td>(2.23)</td>
<td>(3.90)</td>
<td>(0.98)</td>
<td>(4.24)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>4814</td>
<td>4814</td>
<td>4814</td>
<td>10004</td>
<td>4534</td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.01</td>
<td>0.16</td>
<td>0.55</td>
<td>0.43</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>Industry FE</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

Table 12: Competition, firm risk, and the cross-section of credit spreads. For a detailed description, refer to Table 10.
Figure 1: Economic environment for the benchmark model. This figure depicts the economic environment of the benchmark model assuming two industries in the economy.
Table 13: Firm volatility, competition and the cross-section of yield spreads

<table>
<thead>
<tr>
<th></th>
<th>Census HHI</th>
<th>Fit HHI</th>
<th>Markup</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Competition × Ex. ret. volatility</td>
<td>18.90</td>
<td>21.39***</td>
<td>21.26***</td>
</tr>
<tr>
<td></td>
<td>(1.21)</td>
<td>(3.28)</td>
<td>(2.74)</td>
</tr>
<tr>
<td>Equity characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatility excess return</td>
<td>50.32***</td>
<td>50.88***</td>
<td>39.95***</td>
</tr>
<tr>
<td></td>
<td>(6.28)</td>
<td>(5.34)</td>
<td>(5.96)</td>
</tr>
<tr>
<td>Mean excess return</td>
<td>-47.90***</td>
<td>-44.71***</td>
<td>-95.82***</td>
</tr>
<tr>
<td></td>
<td>(-3.60)</td>
<td>(-3.98)</td>
<td>(-4.95)</td>
</tr>
<tr>
<td>Total debt to capitalization</td>
<td>-145.95**</td>
<td>12.35</td>
<td>-42.77</td>
</tr>
<tr>
<td></td>
<td>(-2.52)</td>
<td>(0.19)</td>
<td>(0.69)</td>
</tr>
<tr>
<td>Asset (log)</td>
<td>45.57***</td>
<td>8.86</td>
<td>24.53*</td>
</tr>
<tr>
<td></td>
<td>(3.21)</td>
<td>(0.50)</td>
<td>(1.73)</td>
</tr>
<tr>
<td>Tangibility</td>
<td>28.29</td>
<td>14.45</td>
<td>22.92</td>
</tr>
<tr>
<td></td>
<td>(1.07)</td>
<td>(0.21)</td>
<td>(0.66)</td>
</tr>
<tr>
<td>Book-to-market (log)</td>
<td>10.76</td>
<td>39.80</td>
<td>14.06</td>
</tr>
<tr>
<td></td>
<td>(0.60)</td>
<td>(1.52)</td>
<td>(1.43)</td>
</tr>
<tr>
<td>Size (log)</td>
<td>-43.82***</td>
<td>-41.34**</td>
<td>-30.22**</td>
</tr>
<tr>
<td></td>
<td>(-3.21)</td>
<td>(-2.69)</td>
<td>(-2.14)</td>
</tr>
<tr>
<td>Bond characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Credit rating</td>
<td>-9.94***</td>
<td>-2.24</td>
<td>-4.92***</td>
</tr>
<tr>
<td></td>
<td>(-4.12)</td>
<td>(-0.51)</td>
<td>(-2.80)</td>
</tr>
<tr>
<td>Years to maturity</td>
<td>1.73***</td>
<td>1.48***</td>
<td>1.93***</td>
</tr>
<tr>
<td></td>
<td>(5.87)</td>
<td>(6.73)</td>
<td>(9.23)</td>
</tr>
<tr>
<td>Coupon rate (in %)</td>
<td>13.54***</td>
<td>16.10***</td>
<td>6.38**</td>
</tr>
<tr>
<td></td>
<td>(4.56)</td>
<td>(3.78)</td>
<td>(2.49)</td>
</tr>
<tr>
<td>Issue size (log)</td>
<td>-9.18**</td>
<td>-11.70***</td>
<td>-3.47</td>
</tr>
<tr>
<td></td>
<td>(-2.24)</td>
<td>(-3.03)</td>
<td>(-1.08)</td>
</tr>
<tr>
<td>Trading turnover</td>
<td>-74.35***</td>
<td>-63.01**</td>
<td>-52.41***</td>
</tr>
<tr>
<td></td>
<td>(-2.89)</td>
<td>(-2.71)</td>
<td>(-3.58)</td>
</tr>
<tr>
<td>Macroeconomic variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3m T-Bill (in %)</td>
<td>-17.61***</td>
<td>-28.58***</td>
<td>-20.79***</td>
</tr>
<tr>
<td></td>
<td>(-6.03)</td>
<td>(-5.39)</td>
<td>(-6.31)</td>
</tr>
<tr>
<td>Term spread (in %)</td>
<td>-7.61</td>
<td>-24.74***</td>
<td>-15.35**</td>
</tr>
<tr>
<td></td>
<td>(-1.58)</td>
<td>(-3.47)</td>
<td>(-2.95)</td>
</tr>
<tr>
<td>1m Eurodollar spread (in %)</td>
<td>27.14***</td>
<td>24.40***</td>
<td>11.26*</td>
</tr>
<tr>
<td></td>
<td>(8.45)</td>
<td>(7.31)</td>
<td>(2.01)</td>
</tr>
<tr>
<td>Labor share</td>
<td>-3.98**</td>
<td>-4.61***</td>
<td>3.23**</td>
</tr>
<tr>
<td></td>
<td>(-2.15)</td>
<td>(-3.01)</td>
<td>(2.19)</td>
</tr>
<tr>
<td>Vol. of daily index ret. (in %)</td>
<td>11.32</td>
<td>18.34</td>
<td>24.65*</td>
</tr>
<tr>
<td></td>
<td>(0.99)</td>
<td>(1.59)</td>
<td>(1.76)</td>
</tr>
<tr>
<td>Mean daily index ret. (in %)</td>
<td>-249.78***</td>
<td>-244.04***</td>
<td>-315.47***</td>
</tr>
<tr>
<td></td>
<td>(-4.59)</td>
<td>(-4.76)</td>
<td>(-7.73)</td>
</tr>
<tr>
<td>Competition</td>
<td>-28.63</td>
<td>-23.43**</td>
<td>-41.68**</td>
</tr>
<tr>
<td></td>
<td>(-0.90)</td>
<td>(-2.18)</td>
<td>(-1.52)</td>
</tr>
<tr>
<td>Constant</td>
<td>41.81***</td>
<td>1058.06***</td>
<td>1376.30***</td>
</tr>
<tr>
<td></td>
<td>(3.05)</td>
<td>(3.90)</td>
<td>(3.59)</td>
</tr>
<tr>
<td>Observations</td>
<td>4814</td>
<td>4814</td>
<td>4814</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.24</td>
<td>0.56</td>
<td>0.64</td>
</tr>
<tr>
<td>Industry FE</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Firm FE</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 13: Competition, firm risk, and the cross-section of credit spreads. For a detailed description, refer to Table 11
Figure 2: Aggregate impulse-response functions. This figure plots the impulse-response function to a positive long-run (red solid) and short-run (blue dashed) productivity shock for productivity growth ($\Delta a$), consumption growth ($\Delta c$), the aggregate Market to Book ratio, the aggregate stock market excess return ($r_e - r_f$), the aggregate default probability (Default), the aggregate credit spread ($cs$), and the aggregate debt and equity payout. The plots are calculated as deviation from the steady state. Units, when applicable, are specified next to the plot title.
Figure 3: Industry variables impulse-response functions. This figure plots the impulse-response functions to a positive long-run productivity shock for industries that differ in their degree of product market competition. The responses in the low-competition industry are plotted in red solid while those in the high-competition industry are plotted in dashed blue. $\Delta a$ denotes productivity growth, $E[\Delta y]$ is the expected production growth in the industry, price is the industry output price relative to the aggregate price index, and $r_i - r_f$ is the industry stock excess return. The plots are calculated as deviation from the steady state. Units, when applicable, are specified next to the plot title.
Figure 4: Idiosyncratic risk shock and industry credit spreads

Figure 4: Impact of an increase in idiosyncratic risk. This figure plots the impulse-response functions to a positive idiosyncratic volatility shock for industries that differ in their degree of product market competition. The responses in the low-competition industry are plotted in red solid while those in the high-competition industry are plotted in dashed blue. $\sigma_z$ denotes the volatility of the idiosyncratic shock. The plots are calculated as deviation from the steady state. Units, when applicable, are specified next to the plot title.
Figure 5: Baa spread time-series for Moody’s and the NAIC panel data. This figure compares the quarterly time series of average Baa bond spreads reported by Moody’s and the same series obtained from the NAIC bond transaction file between 1995 and 2012. Yield spreads are in basis points. Bonds from NAIC are in U.S. dollars and have no special features (call, put, convertibility, etc.).
A A simple model: derivation details

A.1 Firm’s problem

First note that shareholders declare default as soon as the value of the firm turns negative. In period 1, the value of the firm is simply \( d_1 \). Therefore the default threshold is the value \( z^* \) that solves \( d_1(z^*) = 0 \), that is

\[
z^* = (P_1 y_{1,t} - W_1 l_1 - (1 + (1 - \tau)C)b) \bar{l}^{-1}
\]

Substituting the price using the inverse demand schedule (Eq. 1), and using the valuation of corporate debt (Eq. 3), and the default threshold (Eq. 45) into the firm’s problem, the objective of the firm becomes

\[
V_j = \max_{l_0, l_1, b_1} \frac{1}{\nu} \left( \sum_{i=1}^n y_{i,t} \right)^{-\frac{1}{\nu}} - \frac{1}{\nu} y_{i,t} - W_0 l_0 - (1 + (1 - \tau)C)b_0 + \beta \Phi(z^*)(1 + C)b_1 + \beta \int_z^{z^*} (z^* - z) d\Phi(z) \bar{l}
\]

Applying Leibniz’ rule, the first order necessary conditions with respect to \( l_t \) and \( b_1 \) are

\[
W_t = \frac{1}{\nu} \left( \sum_{i=1}^n y_{i,t} \right)^{-\frac{1}{\nu}} \left( \frac{1}{\nu} \sum_{i=1}^n \frac{y_{i,t}}{l_{i,t}} \right) - \frac{1}{\nu} \frac{y_{i,t}}{l_{i,t}} \left( 1 - \frac{1}{\nu} \frac{y_{i,t}}{l_{i,t}} \sum_{i=1}^n y_{i,t} \right) \Phi(z^*) \tau C = \phi(z^*)(1 + (1 - \tau)C)(1 + C)\tilde{b}
\]

Each firm in the industry faces the same problem and differs only by the realization of the idiosyncratic shock \( z \). Because this cost enters as a fixed cost, it doesn’t affect individual firm decisions so that the industry admits a unique symmetric Nash equilibrium in which all firms make identical decisions. The \( i \)-subscript can be dropped and \( \bar{l} = \bar{t} \). Imposing the market clearing on the goods market that demand must equal supply in equilibrium, we have \( n y_{t} = Y_t = \gamma_t \). Imposing market clearing on the labor market, i.e. \( n l_t = 1 \), the set of FOCs becomes

\[
W = \left( 1 - \frac{h}{\nu} \right) A
\]

\[
\Phi(z^*) \tau C = \phi(z^*)(1 + (1 - \tau)C)(1 + C)\tilde{b}
\]

where \( h = \sum_{i=1}^n (y_{i,t}/Y_t)^2 = 1/n \) is the Herfindahl-Hirschman index of the industry, and \( \tilde{b} = b/\bar{l} \) is a measure of leverage (debt over the firm size).
The price-elasticity of demand \( \eta_{y,P} \) in the symmetric equilibrium is obtained using Eq. (49):

\[
\eta_{y,P} = -\frac{\partial y_{i,t}}{\partial P_t} = \frac{\nu}{h}
\]

### A.2 Proof of proposition 1

**Proof.** First, note that I assume that \( z^* \) is an interior solution on the interval \([-a/2, a/2] \).

In addition, under the assumption that \( z \) is uniformly distributed on \([-a/2, a/2]\), the cumulative distribution function is

\[
\Phi(x) = \begin{cases} 
0 & x < -a/2 \\
\frac{1}{a} (x + \frac{a}{2}) & -a/2 \leq x \leq a/2 \\
1 & x < a/2 
\end{cases}
\]

and the associated probability density function is \( \phi(x) = \frac{1}{a} \). Using the set of equilibrium conditions (48), and the default threshold (45), the equilibrium default threshold is given by

\[
z^* = \left( \frac{hA}{\nu} - \frac{a}{2} \frac{\tau C}{(1 + C)} \right) \left( 1 + \frac{\tau C}{(1 + C)} \right)^{-1}
\]

To prove the effects of competition on the expected default probability, I take the partial derivative of \( z^* \) with respect to \( h \),

\[
\frac{\partial z^*}{\partial h} = A \left( 1 + \frac{\tau C}{1 + C} \right)^{-1}
\]

which is positive. Therefore an increase in competition (decrease in \( h \)) decreases the optimal default threshold and the survival probability of the firm, \( \Phi(z^*) \).

To see the effect on debt, note that equilibrium leverage is given by

\[
\tilde{b} = \left( z^* + \frac{a}{2} \right) \frac{\tau C}{(1 + (1 - \tau)C)(1 + C)}
\]

The result follows from the fact that \( z^* \) is increasing in \( h \).

Next, the equilibrium firm value over labor is

\[
\tilde{V}(A) = \frac{hA}{\nu} - (1 + (1 - \tau)C)\tilde{b}_0 + \beta [\Phi(z^*)(1 + C)] \tilde{b}_1(z^*) + \beta \int_{\tilde{z}}^{z^*} [z^* - z] \ d\Phi(z)
\]

where \( \tilde{b}_1(z^*) \) is the optimal leverage. Plugging the optimal policy for \( \tilde{b}(z^*) \) and taking the partial

\footnote{This is without loss of generality as one can always find a value for \( a \) such that it holds.}
derivative with respect to $h$,

$$
\frac{\partial \tilde{V}(A)}{\partial h} = \frac{A}{\nu} + \beta \left\{ \frac{\tau C \Phi(z^*)}{(1 + (1 - \tau)C)} \left[ 2 - \frac{\Phi(z^*) \phi'(z^*)}{\phi^2(z^*)} \right] + \Phi(z^*) \right\} \frac{\partial z^*}{\partial h}
$$

(55)

where the second line is obtained using the expression for $\frac{\partial z^*}{\partial h}$ in Eq. 52. The term inside the parentheses is strictly positive, implying that the firm value is a increasing function of concentration and therefore a decreasing function of competition.

Finally, the credit spread is defined as $cs = (1 + C)/q - \beta^{-1}$, therefore

$$
\frac{\partial cs}{\partial h} = -\frac{(1 + C)}{q^2} \frac{\partial q}{\partial h} = -\beta \phi(z^*) \frac{(1 + C)^2}{q^2} \frac{\partial z^*}{\partial h} < 0
$$

(56)

where the inequality sign follows from Eq. 52.

\[\square\]

### A.3 Conditional equity beta

**Proof.** Formally, the conditional equity beta is measured as the elasticity of $V_j$ with respect to $A$,

$$
\beta_i = \frac{d \log \tilde{V}_j(A)}{d \log A} = \frac{Ah}{\nu} \left( 1 + \frac{\beta \Phi(z^*)}{1 + (1 - \tau)C} \right) \frac{1}{\tilde{V}(A)}
$$

(57)

$$
= \frac{1 + \beta \Phi(z^*) \frac{1 + C}{1 + (1 - \tau)C}}{1 + \frac{\nu a \beta}{2} \Phi^2(z^*) \left( \frac{z}{1 + (1 - \tau)C} \right)}
$$

Taking the partial derivative of $\beta_i$ with respect to $h$ is somewhat more involved, however, it can be shown that a sufficient condition for $\frac{\partial \beta_i}{\partial h} > 0$ is $\tau < 1$, which is always the case. Therefore an increase in competition decreases the firm conditional beta.

\[\square\]

To obtain the expression for the conditional equity beta in Eq. 8, note that the normalized value of the firm can be rewritten as

$$
\tilde{V}_j(A) = \frac{Ah}{\nu} (1 + \beta) - (1 + (1 - \tau))\tilde{b}_0 + \beta \left[ \Phi(z^*)\tilde{b}_1 \tau C - (1 - \Phi(z^*)) \right] \frac{Ah}{\nu} - \beta \int_{z^*}^{z^*} \, d\Phi(z)
$$

(58)

Rewriting the expression for the conditional equity beta (Eq. 57), I get

$$
\beta_i = 1 + \frac{(1 + (1 - \tau)C)\tilde{b}_0}{\tilde{V}_j(A)} + \frac{\beta \tau C}{\tilde{V}_j(A)} \frac{\Phi(z^*)z^*}{1 + (1 - \tau)C} - \frac{\beta \int_{z^*}^{z^*} \, d\Phi(z)}{\tilde{V}_j(A)}
$$

(59)
B Shareholders’ optimization problem

To keep notation readable, the \((i,j)\)-subscript is omitted, unless necessary but all lower case variables should be understood as firm-specific variables.

**Optimization problem** Assuming that the firm doesn’t default in the current period, and replacing for \(\hat{p}_{j,t}\) using the inverse demand schedule, the recursive representation of the Lagrangian for the shareholders’ problem is

\[
L(b_t, k_t, z_t, \Upsilon_t) = (1 - \tau)\left(\frac{1}{\nu} (Y_{j,t}^- + y_t)^{\nu - 1} y_t - W_t I_t - z_{i,j,t} k_{j,t}^{-1}\right) - i_t + \tau \delta k_t \\
- ((1 - \tau) C + 1) b_t + q_i b_{i+1} - \psi_b(b_t, b_{i+1}) \\
+ \Lambda_{k}^{K} (1 - \delta_k) k_t + \Gamma \left(\frac{k_t}{k_{i+1}}\right) k_t - k_{i+1} \\
+ E_t M_{t,t+1} \int \hat{z} \hat{L}(b_{t+1} + k_{t+1}, z', \Upsilon_{t+1}) d\Phi(z')
\]

(60)

where \(Y_{j,t}^- = \sum_{k=1,k \neq i}^{n_j} y_{k,j,t}\) is the total industry output produced by the firm’s rivals, and \(\Lambda_{k}^{K}\) is the Lagrange multiplier on the capital accumulation equation. The set of first order necessary conditions are:

\[
\begin{align*}
[i_t] : \Lambda_{k}^{K} \Gamma'_{t} &= 1 \\
[l_t] : \hat{P}_{j,t} \left[1 - \frac{1}{\nu} \frac{y_t}{Y_{j,t}^-}\right] (1 - \alpha) \frac{y_t}{k_t} - W_t &= 0 \\
[b_{t+1}] : q_{k,t} b_{t+1} - \Lambda_{k}^{K} + E_t M_{t,t+1} \int \hat{z} \hat{L}_{k,t+1} d\Phi(z') &= 0 \\
[b_{t+1}] : q_{b,t} b_{t+1} + q_t - \psi_{b,2,t} + E_t M_{t,t+1} \int \hat{z} \hat{L}_{b,t+1} d\Phi(z') &= 0
\end{align*}
\]

(61)

where I use the following notation: \(\Gamma'_{t} = \partial \Gamma_{t}/\partial (i_t/k_t), q'_{k,t} = \partial q_t/\partial k_{t+1}, q'_{b,t} = \partial q_t/\partial b_{t+1}, L'_{k,t} = \partial L_{k,t}/\partial k_t, L'_{b,t} = \partial L_{b,t}/\partial b_t, \psi'_{b,1,t} = \partial \psi_{b,t}/\partial b_t, \) and \(\psi'_{b,2,t} = \partial \psi_{b,t}/\partial b_{t+1}. \) \(L'_{k,t}\) and \(L'_{b,t}\) are obtained by applying the envelope theorem,

\[
\begin{align*}
L'_{k,t} &= (1 - \tau) \hat{P}_{j,t} \left[1 - \frac{1}{\nu} \frac{y_t}{Y_{j,t}^-}\right] \frac{y_t}{k_{t}} + \tau \delta k + \Lambda_{k}^{K} (1 - \delta_k + \Gamma_t - \Gamma'_{t} \frac{k_t}{k_{i+1}}) \\
L'_{b,t} &= - ((1 - \tau) C + 1) - \psi'_{b,1,t}
\end{align*}
\]

(62)

Finally, \(q'_{k,t}\) and \(q'_{b,t}\) are obtained by taking partial derivatives of total debt value \(q_t b_{t+1}\) with respect
to $b_t + 1$ and $k_{t+1}$\textsuperscript{47}:

$$q_{b,t} b_{t+1} + q_t = E_t M_{t,t+1} \left[ (C+1) \Phi(z_{t+1}^*) + z_{b,t+1}^* \phi(z_{t+1}^*) b_{t+1} (\tau C + \xi_{t+1} [(1 - \tau) C + 1]) \right]$$

$$q_{k,t} b_{t+1} = E_t M_{t,t+1} \left[ z_{k,t+1}^* \phi(z_{t+1}^*) b_{t+1} (\tau C + \xi_{t+1} [(1 - \tau) C + 1]) + (1 - \xi_{t+1}) \int_{z_{t+1}}^{\bar{z}} \mathcal{L}_{k,t+1}^* d\Phi(z') \right]$$

(63)

where

$$z_{k,t}^* = \frac{\mathcal{L}_{k,t}^*}{(1 - \tau) k_{j,t}}$$

$$z_{b,t}^* = \frac{\mathcal{L}_{b,t}^*}{(1 - \tau) k_{j,t}}$$

(64)

Note that Eq. 23 is obtained by replacing for $z_{k,t}^*$ and $q_{k,t}$ in the capital FOC.

**Symmetric equilibrium** Because each firm is ex-ante identical and the i.i.d. shock enters as a fixed costs, all firms make the same decisions and the model admits a symmetric Nash equilibrium in each industry. In particular, we have $y_{i,j,t} = y_{j,t}$, $Y_{j,t} = n_j y_{j,t}$, $l_{i,j,t} = l_{j,t}$, $k_{i,j,t} = k_{j,t} = \bar{k}_{j,t}$, and $b_{i,j,t} = b_{j,t}$.

**Price markups** Using the first order condition with respect to labor, and the symmetric property of the equilibrium,

$$\tilde{P}_{j,t} \left( 1 - \frac{h_j}{\nu} \right) = \frac{W_j}{(1 - \alpha) \bar{y}_{j,t}}$$

(65)

where $h_j = 1/n_j$ is the Herfindahl-Hirschman index. The right-hand-side is the firm real marginal cost of production. Defining the price markup to be the price set by the firm over marginal cost, the price markup is,

$$\mu_{j,t} = \left( 1 - \frac{h_j}{\nu} \right)^{-1}$$

(66)

**C Derivation of inverse demand schedule**

The final goods firm solves the following profit maximization problem

$$\max_{Y_{j,t}, \xi_{j,t} \in [0,1]} \mathcal{P}_t \left( \int_{0}^{1} Y_{j,t}^\nu \xi_{j,t}^{-\nu+1} dj \right)^{\frac{1}{\nu-1}} - \int_{0}^{1} \tilde{P}_{j,t} Y_{j,t} \ dj$$

(67)

\textsuperscript{47}It is implicitly assumed that although creditors inherit an unlevered firm in bankruptcy, the debt adjustment cost is paid on the leverage level at the time of bankruptcy.
where $P_t$ is the price of the final good (taken as given), $Y_{j,t}$ is the amount of input bought from industry $j$, and $P_{j,t}$ is the unit price of that input, $j \in [0, 1]$.

The first-order condition with respect to $Y_{j,t}$ is

$$P_t \left( \int_0^1 Y_{j,t}^{\frac{\nu-1}{\nu}} \, dj \right)^{\frac{\nu}{\nu-1}} Y_{j,t}^{\frac{1}{\nu}} - P_{j,t} = 0 \quad (68)$$

which can be rewritten as

$$Y_{j,t} = Y_t \left( \frac{P_{j,t}}{P_t} \right)^{-\nu} \quad (69)$$

Using the expression above, for any two industries $j, k \in [0, 1],

$$Y_{j,t} = Y_{k,t} \left( \frac{P_{j,t}}{P_{k,t}} \right)^{-\nu} \quad (70)$$

Raising the expression above to the power of $\frac{\nu-1}{\nu}$, integrating over $j$ and raising the expression to the power of $\frac{\nu}{\nu-1}$,

$$Y_{j,t} = Y_t \left( \frac{P_{j,t}}{\int_0^1 P_{j,t}^{1-\nu} \, dj} \right)^{-\nu} \quad (71)$$

Using (69), I obtain the expression for the price index

$$P_t = \left( \int_0^1 P_{j,t}^{1-\nu} \, dj \right)^{\frac{1}{\nu-1}} \quad (72)$$