MANAGER ATTENTION AND LEVERAGE DYNAMICS

by

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ABSTRACT

I examine the attention of executive managers and their financing behavior, focusing on the information acquisition process. Corporations are sensitive to both macroeconomic and firm-specific challenges. Executives must choose overall attention capacity and divide finite attention between these topics. By using natural language processing and quarterly earnings call transcripts, I assess the information content of this dialog. The attention capacity quantifies the effective information used to make borrowing decisions, consisting of information processing macro and firm-specific issues. The attention allocation measures the ratio of attention paid to macroeconomics. Executives make two critical decisions during the information acquiring process. First, executives decide the overall attention capacity, determined by the general uncertainty. Second, executives decide the optimal attention ratio allocated between macro and firm-specific topics. In the rise of uncertainty from either subject, executives expand attention capacity (scale effect) and assign greater awareness to this topic (substitution effect). I show that the relative importance of these two effects depends on the relative size of uncertainty. Using an optimal static capital structure model with endogenous information choice, I demonstrate that an executive can tolerate a higher leverage rate when actively acquiring information. Thus, the information decision process is crucial to understanding the recent rising leverage phenomenon.

Keywords: leverage ratio, information rigidity, natural language processing, macro and firm-specific shocks

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1. Introduction

The recent nonfinancial business leverage has mounted to a record-high level[1]. The corporate finance literature addresses the impact of the business cycle on firms' financial decisions (Duffie et al., 2003; Fama, 1986; Hackbarth et al., 2006), but the counter-cyclical dynamics, volatility and heterogeneity of the empirical leverage ratio require further explanation[2]. Corporate finance literature traditionally analyze the firm-level leverage variation with firm characteristics, liquidity, adjustment cost and policy[3]. This study introduces and discusses a behavior factor—attention.

The economic and business environments are constantly changing, and new information emerges simultaneously. Meanwhile, executive managers must plan ahead of time for operational business, such as the supply chain, and financing. How do managers acquire the new information and use it to form an expectation? This question has been well discussed in the operation side of the business. Two major focuses are, the frequency of information updating and full information. Mankiw and Reis (2002) argue that agents don't update information frequently but can obtain full information once they update. Sims (2003) and Sims (2010) propose that agents constantly update information, but cannot access full information. The two seminal models above provide distinct underline mechanism to explain the information rigidity. The two theories point to the same fact: agents are inattentive. Being partially attentive is prevalent in business and among executive managers[4].

A further question emerges naturally and demands further discussion. That is, what determines the agent information updating and expectation formation efficiency? Baker et al. (2020), Gabaix (2019), Zhang (2017), and Chen et al. (2021) provide insights on attention and discuss the role of uncertainty in determining of agents' attention. Research on information rigidity commonly treats attention capacity and attention allocation as

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[1]See Figure A.1. The debt securities and loans of U.S. non-financial corporate businesses over GDP reach 52% in Quarter four, 2020. See Board of Governors of the Federal Reserve System (US), Non-financial Corporate Business; Debt Securities and Loans; Liability, Level [BCNSDODNS], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/BCNSDODNS, June 30, 2021.

[2]Lemmon et al. (2008) points out that firm-level leverage has an unexplained time-varying component. Graham and Leary (2011) makes the same argument of cross-section leverage variations

[3]See Hackbarth et al. (2006), Karpavičius and Yu (2017), Faccio and Xu (2015), Heider and Ljungqvist (2015), Leary (2009) and Jordà et al. (2020). Faccio and Xu (2015) and Heider and Ljungqvist (2015) find a significant positive correlation between tax rate and leverage ratio.

[4]Both inner communication (Robson and Tourish, 2005) and external environment (Hassan et al., 2019; Baker et al., 2016), require managerial attention, information acquisition and information processing.

constant. The agents' ability to learn from new information and the attention ratio allocated to each field is assumed to be constant over time. Does managerial attention capacity stay constant? What factors do managers consider when optimizing information decisions? Does limited attention affect firm-level capital structure? Can managerial attention help explain the unprecedented high level of business leverage?

Extending the literature, this paper investigates the following three aspects. First, the discussion of the role of attention stays in the real business side of firm-level choice. I first investigate the role of attention in agents' financing choice. Specifically, I focus on executive managers' attention. Second, direct attention measurement has been a challenge because it is an abstract concept. I provide two novel attention measurements with the techniques of natural language processing, and then discuss what determines the agents' attention. Third, I discuss the relationship between attention, uncertainty and firm-level leverage ratio theoretically. Managers choose their attention capacity and attention allocation before making optimal financial decisions.

When measuring executives' attention, I use the quarterly earnings call transcripts. Public listed firms are required by the US Securities and Exchange Commission (SEC) to host quarterly earnings conference calls. The purpose is to reveal information about company operations and exchange information with investors. During the conference, the executive managers present and discuss a company's current and future operation, revenue, cash flow and financing status. The documented text thus reveals managers' attention and work priories. Using this text data, I construct two novel firm-level attention measurements for 3481 firms and examine the quantity and priority of manager attention. Attention capacity, which is the sum of attention paid to macroeconomic and firm-specific components, measures the volume of effective information that a manager processes to make a financial decision. The attention allocation describes the ratio of attention that a manager distributes to each component. After discussing the construction and validation of the attention measures, I use the new time series of firm-level attention to document several new findings. Details about the measurements can be found in Section Two.

At the aggregate level, attention capacity is counter cyclical whereas attention allocated to macroeconomics has an upward trend. Heterogeneity exists and the cross-section distribution variances of both indexes become larger during recessions. Further analysis documents that managerial attention capacity positively correlates with firm size, profitability, tangibility, market to book value and leverage. Attention allocation is positively related to firm size and profitability, while it is negatively correlated with the market-to-book value, tangibility and leverage. Attention capacity is time-variant and affected by uncertainty in the business environment. The uncertainty comes from two parts, macro and firm-specific components, in which the mechanism of information work in the same

way. It is difficult to analyze when the uncertainty in both components change simultaneously. To simplify the process, I keep the firm-specific volatility constant while making the macrovolatility variant for most cases throughout this paper. The effect stays the same either way.

There are three key findings in the empirical analysis. First, in aggregation, attention capacity is counter-cyclical, and attention allocated toward macroeconomics increases during the sample period. Second, attention capacity positively relates to the leverage ratio, while attention allocation is negatively related to the leverage ratio at the firm-level. Finally, managerial information choices depend on the volatility of the shocks (Macro and firm-specific) instead of the first moment. The empirical results reflect the close relationship between managerial information and financial decisions. Ahead of making a financial decision, executive need to make an information decision: chooses the attention capacity and decides an optimal ratio of attention allocation. Attention capacity is positively related to the overall uncertainty. When the overall uncertainty increases, executive managers want to seek for more information and thus expand the attention capacity, which I name as the scale effect. As for the attention allocation, the changes depend on the uncertainty in which aspect is higher, which I name as the substitution effect.

Suppose the firm-specific volatility stays constant, higher macro-volatility leads to increased managerial attention to macroeconomics and improved attention capacity. With the increased attention capacity, managers gain more information about the fundamental economy and thus improve the precision of estimated optimal financial structure. Managers can choose to have a higher leverage by being more aware of their own financing situation. Simultaneously, paying attention to macroeconomics can crowd out the attention allocated to firm-specific issues, resulting in lower estimation precision, making managers conservative about borrowing decisions. This finding is robust when considering firms' financial constraints and industrial cyclical sensitivity. I also find that the information channel represented by attention capacity and attention allocation can amplify the effect of the business cycle on the leverage ratio. Motivated by high macro-uncertainty, managers choose to pay more attention to macroeconomics and increase the weight of macro-factors when making an optimal financing decision. I also found that when adding an aggregate uncertainty measurement, the coefficient of GDP growth rate becomes insignificant, suggesting that the information channel connects the macro-environment through the second moment instead of the first moment. The substitution effect is higher than the scale effect with both empirical evidence and theoretical setup.

The findings in the empirical part motivate the design of the theoretical model. Following the theory of rational inattention, I assume that agents have limited attention and cannot process all the available information. Managers' attention capacity and atten-

tion allocation are inertial in financial decision making because they determine managers' belief about the internal and external environment and estimation precision of future conditions. Three major elements are incorporated into a firm's financial decisions. First, a representative firm chooses an optimal information decision before maximizing the value of the firm. The information decision consists of attention capacity, the amount of information, and attention allocation, which is how to allocate limited attention between macroeconomics and firm-specific issues. Second, the decisions of attention capacity are based on the total volatility of the company. Third, the attention allocation intakes the variation in both the attention capacity and comparative variances of macroeconomic versus firm-specific components. The information choice is time-varying.

This paper makes three contributions. First, by using quarterly earnings call transcripts and natural language processing (NLP), I construct two novel firm-level measurements of managers' attention: attention capacity and attention allocation. Attention capacity measures the amount of effective information that managers acquired. Attention allocation measures the ratio of attention distributed to macroeconomics. Both the measurements are time varying, indicating that managerial attention capacity and attention allocation are correlated with other time-varying factors. Consistent with information rigidity theory, the agent's attention capacity index is positively correlated with the variance of related variables. For example, the attention capacity is higher during a recession, when the economic uncertainty is high. Second, I investigate if the time-varying attention measurements help explain the variance and heterogeneity of firm-level leverage ratio. With these two measurements, I document that managers' leverage ratio decisions are positively correlated with their attention capacity and negatively correlated with attention allocation toward macroeconomics. To interpret the correlations, paying attention to macroeconomics has both substitution and scale effects on managerial financial decisions using firm-specific information. By looking at the role of the business cycle, I further document that managerial attention to macroeconomics amplifies the effect of the business cycle on the firm-level leverage ratio. Finally, I build a theoretical model integrating rational inattention theory and corporate finance. The rational inattention theory is extended to geometric Brownian motion. The model aims at making managerial information choice endogenous based on the precision of past estimation. The model reproduces the same phenomenology as found in empirical analysis.

Related Literature This paper relates to three strands of literature. The first addresses the role of macroeconomics in a firm's financial decision. The second strand highlights the role of information rigidity in agents' decision-making processes. The last strand of literature attempts to use machine learning techniques and text data to measure abstract concepts in economics, such as uncertainty, risk and attention.

Since the seminal work of Modigliani and Miller (1958), economists have tried understanding firms' financing policies quantitatively. Traditional studies of corporate finance focus more on firm-specific conditions[5]. A heightened volume of research appearing in the past 20 years highlights the role of macroeconomics in determining capital structure[6]. Business cycles can affect a firm's financial choice with default risk, credit risk, liquidity and cash flow[7]. Several discrepancies remain in both the theoretical and empirical results. First, theoretical studies yield both pro-cyclical and counter-cyclical patterns of leverage ratio[8]. A large variation and heterogeneity in a firm's leverage choice[9] remains unexplained.

This study contributes to the corporate finance literature in the following three ways: 1) I introduce rational inattention as a new factor including firm-level leverage variations. Corporations are critically sensitive to both the macroeconomic environment and firm-specific challenges. Being attentive to macroeconomics increases the firm's leverage ratio by expanding the attention capacity. Paying attention to macroeconomics, in contrast, lowers the leverage ratio by crowding out managers' focus on firm-specific issues. 2) I study the information channel, through which the business cycle influences the leverage ratio. The results further indicate that the aggregate uncertainty contributes to the influence instead of the first moment. 3) I introduce time-varying attention capacity and attention allocation into a static optimal capital structure model. Before making firm value-maximizing decisions, managers make optimal information decisions.

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[5]Titman and Wessels (1988), Rajan and Zingales (1995), Hovakimian et al. (2001) and Hovakimian et al. (2004) provide evidence that various firm characteristics are related to a firm's leverage ratio.

[6]Choe et al. (1993) first show that macroeconomics are important factors of a firm's financing choices. Levy and Hennessy (2007) and Brunnermeier and Krishnamurthy (2020) share the same idea. Indeed the three major theories (trade-off, pecking-order, and market timing) of a firm's financing decisions all emphasize the role of macroeconomics.

[7]Fama (1986), and Duffie et al. (2003) provide evidence that business cycles impact the probability of default. Hackbarth et al. (2006) study the role of credit risk. Faulkender and Petersen (2006) first document the role of the supply-side of liquidity. Firms that have access to public bond markets choose to have more leverage

[8]Hackbarth et al. (2006) reported counter-cyclical leverage. Similar results are found in Levy and Hennessy (2007) with less financially-constrained firms, Chen (2010) with firm's actual leverage ratio, Halling et al. (2016) with a target leverage ratio, and Erel et al. (2012) with financially unconstrained firms. In contrast, Bhamra et al. (2010) found that the capital structure was pro-cyclical using a consumption-based asset-pricing model. Chen (2010) found the firm's target leverage ratio to be pro-cyclical. Erel et al. (2012) found the capital raising of non-investment-grade borrowers pro-cyclical.

[9]Korajczyk and Levy (2003) document that macroeconomic conditions affects financially unconstrained firm's capital structure choice but not for financially constrained firms. Begenau and Salomao (2019) note that large and small firms use different financing policies over the business cycle.

This paper also closely connects with the information rigidity literature. As Gabaix (2019) points out, "Traditional rational economics assumes that we process all the information that is freely available to us." Much research shows that agents' attention level is roughly halfway between paying attention and not paying attention (Gabaix, 2019). A new wave of studies investigate the role of an agent's attention in the decision-making process. Most research focuses on the real economic activity, such as consumer decisions, managers' decisions on real production and hiring, professional forecasters' behavior on forecasting (Maćkowiak et al., 2009; Maćkowiak and Wiederholt, 2015; Coibion and Gorodnichenko, 2015; Flynn and Sastry, 2021; Andrade et al., 2021; Chen et al., 2021). Recent findings show that managers treat information from macro and micro-sources differently[10].

A few papers have shed lights on information rigidity in finance. Efforts are mostly made to explain an investor's investment behavior. Kacperczyk et al. (2016) investigate if mutual fund managers allocate attention rationally. They use an attention allocation model and find that some investment managers have skill and that attention is allocated rationally. Sicherman et al. (2016) exam investors' financial attention by using novel panel data on daily investor online account logins. They find that investor attention declines when the volatility index (VIX) arises. Hirshleifer and Sheng (2021) study firm-level earnings announcements. They find that besides substitution effects, there is also a complementary relationship between macro- and micro-news. Dessein and Santos (2021) build a theoretical model and focus on the allocation of managerial attention. They yield that a manager's behavior matters more in a complex environment. Hirshleifer and Teoh (2003) point out that investors have limited attention and ability to process information. Hirshleifer et al. (2009) demonstrate that limited attention results in market reactions to relevant news. Overall, there are a good number of theoretical articles. Comparatively, empirical research on attention has been slowly conducted because of measurement challenges. Peng and Xiong (2006) discover that investors' limited attention leads to category-learning behavior. Investors allocate more attention to market and sectoral information than to firm-specific information. Other related paper includes Peng (2005) and Van Nieuwerburgh and Veldkamp (2010).

There are, so far, six ways to measure attention[11]: 1) deviations from optimal action (Coibion and Gorodnichenko, 2015; Baker et al., 2020; An, 2019); 2) deviations

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[10]Meyer et al. (2021), Chen et al. (2021) and Candia et al. (2021) show that compared to firm-specific issues, managers pay less attention to macro-conditions. Candia et al. (2021) further points out that the inflation expectations of U.S. managers appear far from anchored. U.S. managers are largely uninformed about recent aggregate inflation dynamics or monetary policy. Maćkowiak et al. (2009) point out that decision-makers in firms pay significantly more attention to sector-specific conditions than to aggregate conditions. For similar findings, see Zhang (2017)

[11]This classification builds on Gabaix's (2019) and DellaVigna's (2009) work.

from normative cross-partials; 3) physical measurement (e.g., eye-tracking); 4) surveys (Meyer et al., 2021; Candia et al., 2021); 5) imputations from the impact of attentional interventions; 6) natural language processing(Hassan et al., 2019, 2021; Flynn and Sastry, 2021). Each method has its pros and cons. Using deviations from optimal action provides accessible data but may cause misalignment issues. The micro-data speak more about more of forecasters' attention than managers' attention. One needs to be aware of this difference when using forecasters' expectations as the proxy of managers' actions. Survey data are straightforward, consistent and timely. The drawback of using survey data is that the process is costly and time consuming. This study used the NLP method. NLP can directly measure managerial attention as revealed by the raw text. It is efficient, objective and easy to replicate.

This paper differs from the literature in the following three ways: 1) I focus on firm-level managerial attention and examine both the quantity and allocation of attention. I first study the factors that can influence managerial attention. The impact of managerial attention also carefully estimated. 2) I provide novel quarterly measurements of attention capacity and attention allocation for around two decades. The use of NLP makes the measurement objective, efficient and replicable. 3) I first incorporate the rational inattention model with a contingent claim paradigm. The possibility of using a rational inattention model under Brownian motion is also explored.

This paper also relates to the application of machine learning and natural language processing in social science. Classic applications can be found in Baker et al. (2016), Hassan et al. (2019, 2021) and Flynn and Sastry (2021). *"Measuring attention is still a hard task" (Gabaix, 2019).* Measuring an abstract concept such as *attention* is challenging. Another independent research using similar methodology is Flynn and Sastry (2021) (hereafter FS), which uses the *term frequency-inverse document frequency (TF-IDF)* and 10-Q documents to construct the macroeconomic attention. They focus on the aggregate level of informativeness and find that firm attention to macroeconomics is counter-cyclical at the aggregate level.

This paper differs from the previous research in the following two ways: 1) I focus on the information perspective of the measurement using TF-IDF and provide rationalization that the two independent measurements are additive; 2) I make the connection of empirical measurement with the rational inattention model based on information theory because both TF-IDF and the rational inattention model are built on information theory and share the same unit—one bit of information.

This paper closely relates to and is inspired by three papers. The first is Flynn and Sastry (2021)(hereafter FS). They use a similar NLP method to generate attention

measurement to macroeconomics and investigate the impact of business cycles on firms' production decisions. My paper differs from FS in the following three ways. FS focuses only on firm's attention to macroeconomics, while I endogenize firm's information decision. By considering managerial attention quantity and allocation choice, I emphasize the role of attention in macroeconomics. In FS, a firm makes fewer mistakes by being attentive to macroeconomics. Whereas, I discovered the substitution and scale effect of managers being attentive to macro-environment. Second, on top of FS's contribution of attention measurement using NLP, my paper further connects information theory with the measurement of TF-IDF. I prove mathematically that using TF-IDF on the same text, the managers' attention to different aspects is additive. Thus, it opens up great possibilities to investigate managers' attention distribution. Third, I focus on the firm's financing decision instead of producing a decision. I first introduce RI into a static optimal capital structure model. My paper is also closely related to Zhang (2017). We conclude from different methods that attention capacity is state-dependent. Zhang (2017) applies Markov-switching factor-augmented vector autoregression (MS-FAVAR) analysis on disaggregate personal consumption expenditure (PCE). Whereas, I directly measure managers' attention using text data. Inspired by the empirical evidence, we make the same assumption, that information decisions depend on the variance of information from different aspects, in the theoretical models. Second, we emphasize the role of attention in macroeconomics. But differently, I focus on firm-level evidence for financing decisions, while Zhang (2017) focuses on sectional evidence and producing decisions. The third closely related paper is Hirshleifer and Sheng (2021). This paper exams the sensitivity of stock market reactions to earnings news on days either with or without major macroeconomic announcements. Their result suggests a complementary relationship between macro-news and firm-level news, while the existing theories suggests that macro and firm-level earnings news are attention substitutes. Similarly, my paper suggest both substitution and scale effects. This paper differs from Hirshleifer and Sheng (2021) with data and agents. Instead of investigating investors and focusing on earnings announcement, I emphasize managers' financial decisions and generate a direct measurement of managerial attention to both macro and firm-specific challenges.

The rest of the paper is structured as follows: Section 2 defines and introduces the measurement of managers' attention capacity and attention allocation, using quarterly earnings call transcripts and TF-IDF. I then discuss the factors that determine attention capacity and attention allocation. The findings reveals the time-varying and heterogeneity of the two measurements. Section 3 investigates the role of managerial attention in making financing decisions. I then examine the effect of business cycle on firm-level leverage ratio and present the evidence of both substitute and scale effects. I focus on firm's financial constraints and cyclical sensitivity for robust tests. Section 4 describes the theoretical model combined by rational inattention framework and optimal capital structure with

contingent claims diagram. Section 5 concludes.

2. Measuring C-Suite's Attention Capacity and Attention Allocation

This section introduces the construction of the two key variables of this paper: attention capacity and attention allocation. I start this section with the definition of attention capacity and attention allocation. I then introduce the text data used to generate the variable, which are the quarterly earnings call transcripts and the textbooks. Next, I show the methods to prepare the documents. Finally, I demonstrate the TF-IDF algorithm in detail, the key terms selected for each attention category, and how to interpret the results. Finally, I present the attention capacity and attention allocation both in aggregation and in firm-level. I also discuss the attention measurements are different from the business cycle itself.

2.1 Attention Capacity and Attention Allocation

Entering the big data era, we are fighting for limited attention and learning to optimally allocate our attention. The limited attention comes from three parts. First, we all have twenty-four hours per day, and we each decide how to make the best of it. Second, most of us can only focus on one thing at a time(Johnston and Pashler, 1998). Multitasking usually lowers one's work efficiency. Third, we have limited capacity for information processing. For example, human performs poorer in complicated computation compared to computers. Sims (2006) points out that due to Shannon capacity, there is always an upper bound of information transaction rate between the input and the output. In this paper, I define managerial attention capacity as the upper bound of information transaction rate when a manager works. This is the key to understand the heterogeneity as well as that executive managers in large firms have on average higher attention capacity than the same level managers in small firms, as I will show in the empirical research part. Because first, acquiring knowledge about the macro environment is harder and more costly than firm-specific issues. Large firms can afford news terminals, such as Bloomberg, and macro consultancy services. Second, large firms usually have larger exposure to macroeconomics, making the cost of not paying attention higher. In another word, executive managers in smaller firms are rationally inattentive to macroeconomic information.

We are making attention allocation decisions all the time. The problem can come from, whether multitasking, should I spend the time working, or have fun in nature. In this paper, I provide a narrow definition of attention allocation. Only considering executive managers' working time, I define attention allocation as the percent ratio of attention

that an executive manager pays to macroeconomic information. Executive managers are known to have tight schedules. When making a decision, they need to consider both the outside environment and only firm-related issues. They also make an effort with both inner and outer communication. Sometimes a decision must be made before thorough considerations. Thus, paying attention to macroeconomics can help managers collect useful information as well as distracts managers from focusing on tasks that are known critical to firm development.

2.2 Quarterly Earnings call Transcripts

I use the quarterly Earnings Call Transcript[12] of publicly listed firms to construct manager's attention. I first measure managers' attention toward macroeconomic and firm-specific conditions separately.

An earnings call conference is held once every quarter before its 10-Q or 10-K available, in the form of teleconference or webcast. A public listed company uses the call as an opportunity to discuss the financial results, the cause, and the forecasting of future operations of a reporting period (quarterly). The calls usually happen when the stock market is closed so that all investors can have a chance to learn about this company's performance before trading. To make sure investors and analysts are informed about the calls, the notices of the earnings calls are usually announced a few days or weeks in advance. The notifications are usually posted on the firm's website under a section named Investor Relations or Investors. Of course, professional financial data providers such as Bloomberg, FactSet, and Thomson Reuters will remind analysts about the upcoming earnings call. For individual investors, brokers such as Robinhood, push the notifications too. Many companies provide the recordings or presentation slides from the calls for investors who missed the meeting. It is worth noting that though the vast majority of firms host the earnings call conference, some small firms with very few investors have the exemption not to host the earnings call. The call often starts with a safe harbor statement [13], a presentation, and a discussion of the firm's financial result and a Q&A session. In the call, the C-Suite also discusses the details of its coming SEC Form 10-Q (quarterly report) or 10-K (annual report).

I choose earnings call transcripts over Form 10-Q for the following three reasons. 1)It consists of the executive manager's speaking, making sure that I'm measuring the

[12]Also used in Hassan et al. (2019), Flynn and Sastry (2021) and Hassan et al. (2021)

[13]A safe harbor statement is made to inform the audience that the discussion can consist of forward-looking statements, which are not factual statements

manager's attention; 2) The statement updates more promptly than the risk part in Form 10-Q, where the same statements can repeat a few times; 3) The call transcripts include a Q& A session where the institutional investors and professional analysts can ask the executive team questions. With the question session, the chance that the executive managers intentionally hide information is smaller than in Form 10-Q and 10-K.

Earnings call transcripts are superior text materials than newspaper articles to measure executive managers' attention. Because newspaper articles reflect more about journalists' attention instead of C-suit managers.

2.3 Textbooks

During the term selection phase, I use three classic textbooks of Corporate Finance to select terms about firm-specific issues. *Essentials of Corporate Finance* by Ross, Stephen A., Randolph Westerfield, Bradford D. Jordan, and Ernest N. Biktimirov, *Financial Reporting and Analysis* by Gibson, Charles H, *Principles of Corporate Finance* by Brealey, Richard A., Stewart C. Myers, Franklin Allen, and Pitabas Mohanty[14]. I use two classic textbooks of Macroeconomics to select terms about macroeconomic conditions. *Macroeconomics Principles and Policy* by Baumol, J. W., and S. A. Blinder.*Principles of Macroeconomics* by Mankiw, N. Gregory, Ronald D. Kneebone, Kenneth James McKenzie, and Nicholas Rowe[15]. I present the justification of using text to reference the most informativeness terms in the *Term Identification* section.

2.4 Preparing The Documents

After obtaining the transcripts from the FactSet database, I conduct the following steps for pre-processing[16]. 1) Each transcript consists of paragraphs and sentences, which are seen as strings in NLP. I perform string tokenization by simply split each document into words and use the Natural Language Toolkit (NLTK)[17] to drop stop words. 2) I use word stemming to normalize the words with the same root. In this way, words with the same word root can be aggregated. Otherwise, the frequency of the words can be underestimated and thus bias the measurement. The same steps apply to textbooks too.

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[14]The edition of the textbooks are 9^{th}, 12^{th} and 12^{th} separately.

[15]The edition of the textbooks are 14^{th} and 6^{th} separately.

[16]Pre-processing refers to the process of converting data to something a computer can understand. Here the goal is to decompose a document into useful words, which serve as a unit.

[17]A common library in Python for Natural Language Processing

The NLP algorithm that I use to conduct this measurement is called *Term Frequency-Inverted Document Frequency (TF-IDF)*. It measures whether a word is frequent in a given document, relative to its frequency in the entire corpus. Here, the single document could be a textbook or an earnings call transcript. The corpus is the set of call transcripts.

2.5 Introducing TF-IDF

I start the demonstration of *TF-IDF* with the definition of the symbols. In this section, w represents each individual term, $d_{f,t}$ represents each individual document for firm f at quarter t, which can also be seen as a vector of w. D represents the set of earnings call transcript documents across all firms f and all quarters t and B represents the set of textbooks b.

The definition of *TF-IDF* is as follows. *term-frequency* can be seen as the occurrence number of each term w over the total number of words in document d. Define N_d as the number of all terms in document d, and define $n_{w,d}$ as the frequency of term w appear in document d.

$$tf(w,d) := \frac{n_{w,d}}{N_d} \tag{1}$$

document-frequency can be seen as the fraction of documents $d_{f,t}$ in the set of documents D, that contains the term w. Define N_D as the number of documents in the set D, and define $n_{w,D}$ as the number of documents $d_{f,t}$ that contains the term w.

$$df(w,D) := \frac{n_{w,D}}{N_D} \tag{2}$$

$$idf(w,D) := log(\frac{1}{df(w,D)}) \tag{3}$$

Putting together, the *tf-idf*, or *term-frequency-inverse-document-frequency*, measures the weighted occurrence of a term in a document relative to its weighted occurrence in the entire corpus:

$$tf\text{-}idf(w,d_{f,t},D) := tf(w,d_{f,t}) \cdot idf(w,D) \tag{4}$$

Equation (1) indicates that $0 \leq tf(w, d_{f,t}) \leq 1$. Equation (2) implies that $0 \leq df(w, D) \leq 1$, thus, in Equation (3), $idf(w, D) \geq 0$. According to information theory, $tf(w, d_{f,t})$ is the probability of a term w appears in a random word in document $d_{f,t}$. Analogically, $df(w, D)$ is the probability of w appears in a random document $d_{f,t}$. Aizawa (2003) demonstrates a way to interpret *tf-idf* from the information theory perspective. $idf(w, D)$ can be seen as the amount of information gain after observing the term w and $tf(w, d_{f,t})$ represents the probability that the term w is observed. *tf-idf* can be the expected information gain of a term w.

2.6 An Example to Present TF-IDF Calculation

In Table 1 below, I present the *tf-idf* and the inter-median calculation process for four represented terms. Comparing *gdp* and *monetari*, *gdp* occurs more in both the textbook and the D corpus, thus *gdp* has higher *tf* and lower *idf*. As the value of *tf-idf* is a simple product of *tf* and *idf*, *gdp* ends up with a higher *tf-idf* value than *monetari*. The term *use* is a very common word. Thus it has a higher frequency in both textbook and the corpus comparing to *monetari*. The *tf* value of *monetari* and *use* is the same, but *use* has a lower *idf*. It means that to my sample corpus, *use* is less informative than *monetari*. Thus, *use* has a much lower *tf-idf* value than *monetari*. *Handicraft*, on the other hand, rarely occur in either textbook or my sample corpus. Though *Handicraft* is very informative (with a high *idf*), it is misleading when expressing macroeconomics news. Thus, *handicraft* has a low *tf-idf* despite a high *idf*. To conclude, *idf* measures the *informativeness* of a term within the corpus, while *tf* measures the *relevance* of a term to a certain context, which in this paper, is the extent to which a term is relevant to macroeconomic or firm-specific conditions.

Table 1: An Example for Term-level *tf-idf* Calculation

Term	Term Frequency	tf	Document Frequency	idf	*tf-idf*
gdp	1080	0.006	11952	2.813	0.017
monetari	494	0.003	3340	4.088	0.011
use	501	0.003	199065	0.00001	0.000000028
handicraft	1	0.000006	1	12.201	0.000068

Note: This table shows an example of intermediate steps while calculating *tf-idf*. The data are extracted from W_{macro} term identification process using *Macroeconomics Principles and Policy* by Baumol, J. W., and S. A. Blinder.

2.7 Term Identification

The goal of this section is to select a set of terms w_{macro} and a set of terms w_{firm} that can represent the informativeness of macroeconomic and idiosyncratic conditions separately in the earnings call transcripts, using each textbook b_i, where i represents textbooks of macroeconomics or corporate finance. I first calculate the $tf(w, b_i)$ for each term w that appears in b. Then for each term w in the earnings call transcript corpus D, I calculate the $idf(w, D)$. Finally, by combining $tf(w, b_i)$ and $idf(w, D)$, I calculate $tf\text{-}idf(w, b_i, D)$. Terms that do not appear in b_i and D, will be dropped automatically at this step. I then take the top 200 terms with the highest $tf\text{-}idf(w, b_i, D)$ values from terms in each textbook b_i, and take the *intersection*[18] to generate the candidate bag of words w_{macro} and w_{firm}[19]. It is possible that w_{macro} and w_{firm} contain the same terms that may bias the measurement; thus, I exclude the mutual terms of the two-word sets from each bag of words. In the next section, I use w_{macro} and w_{firm} to construct the manager's attention toward macroeconomic and idiosyncratic conditions. Table 2 below shows the final terms for each category.

Table 2: Terms Selected with TF-IDF (shorted list)

Category	Terms
Macro (28)	inflat, unemploy, polici, aggreg, economi, suppli, wage, export, govern, recess, nation, demand, labor, phillip, fiscal, consumpt, feder, econom, consum, employ, macroeconom, currenc, crisi, tariff, foreign, deflat, polit, societi
Firm-specific (24)	bond, dividend, stock, discount, equiti, return, financ, loan, yield, asset, payment, inventori, matur, valuat, borrow, debt, paid, premium, payabl, flow, tax, analysi, pay, depreci

Note: This table presents the terms with highest tf-idf. Table A.2 presents a full list. I use the following three textbooks of corporate finance to select firm-specific terms. *Essentials of Corporate Finance* by Ross, Stephen A., Randolph Westerfield, Bradford D. Jordan, and Ernest N. Biktimirov, *Financial Reporting and Analysis* by Gibson, Charles H, *Principles of Corporate Finance* by Brealey, Richard A., Stewart C. Myers, Franklin Allen, and Pitabas Mohanty. I use the following two textbooks of macroeconomics to select terms about macroeconomic conditions. *Macroeconomics Principles and Policy* by Baumol, J. W., and S. A. Blinder.*Principles of macroeconomics* by Mankiw, N. Gregory, Ronald D. Kneebone, Kenneth James McKenzie, and Nicholas Rowe.

2.8 Construct the Measurements

The firm-level attention to macroeconomic conditions and firm-specific conditions is defined as follows:

[18]This step helps to eliminate bias from any single textbook.

[19]For macroeconomics, I take intersection across terms of two textbooks, and for firm-specific conditions, I take intersection across terms of three textbooks.

$$AttentionToMacro(f,t) := \sum_{w \in w_{macro}} tf\text{-}idf(w, d_{f,t}, D) \tag{5}$$

$$AttentionToFirm(f,t) := \sum_{w \in w_{firm}} tf\text{-}idf(w, d_{f,t}, D) \tag{6}$$

To construct the panel database of the manager's attention capacity, I simply take the sum of $AttentionToMacro(f,t)$ (hereafter ATM) and $AttentionToFirm(f,t)$ (hereafter ATF). The simple summation operation is derived from the additivity of channel capacity[20]. To adjust for the scale for a better display, I also multiply the obtained value by 100. For attention allocation, I define it as the manager's attention allocated to macroeconomics. I multiply the value by 100 to present it as a percentage.

$$AttentionCapacity(f,t) := (ATM(f,t) + ATF(f,t)) \times 100 \tag{7}$$

$$AttentionAllocation(f,t) := \frac{ATM(f,t) \times 100}{AttentionCapacity(f,t)} \times 100 \tag{8}$$

In the following sections, I will mainly use $AttentionCapacity$ and $AttentionAllocation$ in the empirical analysis and the theoretical model.

2.9 Presenting the Managers' Attention

In this section, I present aggregated attention capacity and attention allocation as well as the distribution of these two variables across all firms at each time t. I also use the constructed novel attention measurements to document the factors that determine managers' attention. The findings are stated as follows:

1. At the firm-level, managerial attention capacity is positively correlated with firm size, profitability, tangibility, market-to-book value and leverage.

2. At the aggregate level, managerial attention capacity is dynamic and counter-cyclical.

3. At the firm-level, managerial attention allocation to macroeconomics is positively correlated with firm size and profitability, and negatively correlated with tangibility, market-

[20]Defined in Shannon (1948); channel capacity is additive over independent channels

to-book value and leverage.

4. At the aggregate level, managerial attention allocated to macroeconomics has a positive drift.

2.9.1 Overall Manager Attention

Figure 1 presents the aggregated executives' attention to macroeconomic and firm-level conditions. The solid line represents the aggregated attention across all firms at each time point t, weighted by the firm size. Firm-level heterogeneity is shown by the box-whisker plots, which demonstrate that attention differences across firms are substantial. Figure 2 shows the aggregated attention capacity and allocation, the key variables in this paper. The managers' attention capacity is counter-cyclical and positively correlated with firm size and profitability, shown in Table 3.

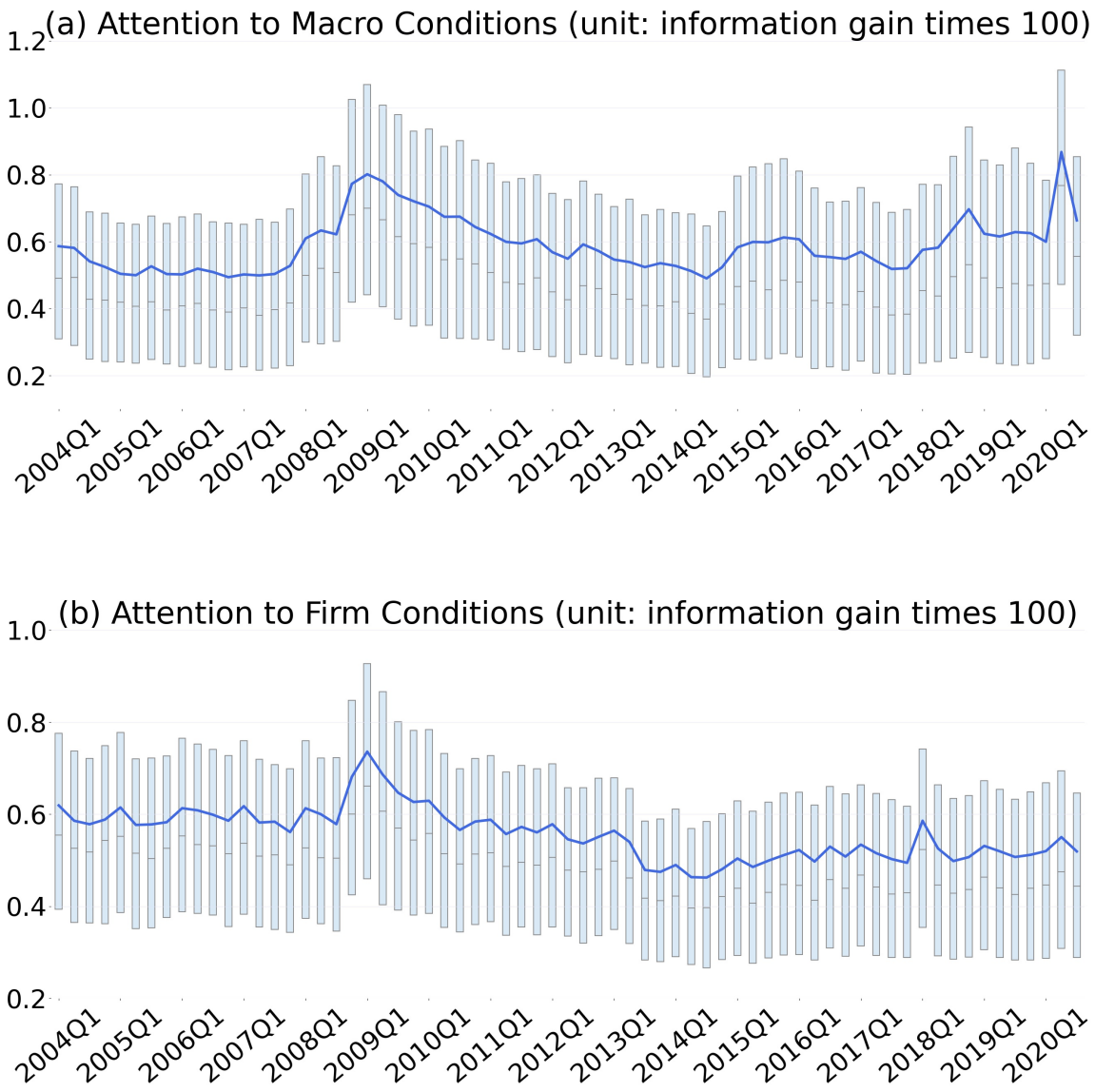
Intuitively, large firms have enough financial resources to afford information about both macroeconomic and idiosyncratic shocks. The counter-cyclical pattern of managers' attention capacity is mainly driven by their attention to macroeconomics. The COVID-19 pandemic triggers more attention to macroeconomics than the 2008 Financial Crisis. No pattern of attention to idiosyncratic shocks has been observed. The COVID-19 pandemic brings more common shocks than idiosyncratic shocks. Figure A.2 shows that the attention differences between big and small firms are consistent. This consistent difference is similar with the findings in Lemmon et al. (2008), which demonstrated that corporate capital structures are stable over long periods.

These findings are consistent with the rational inattention theory. When the uncertainty of the aggregate environment is high, agents pay more attention to optimize the information choices. Firms expand more than 30% of their attention capacity toward macroeconomics during economic downturns in the aggregate.

2.9.2 Cross-sectional Heterogeneity and Managerial Attention

A natural question arises about what factors determine the revealed attention capacity and attention allocation. Data show that a manager's attention capacity is positively correlated with firm size, profitability, tangibility, market-to-book value, and leverage, while it is negatively correlated with the real GDP growth rate. The managers' attention allocation is positively correlated with firm size and profitability, while it is negatively correlated with the market-to-book value, tangibility, leverage, and real GDP growth rate.

Figure 1: Aggregated Manager's Attention Toward Macro and Idiosyncratic Conditions, 2004Q1 - 2020Q3

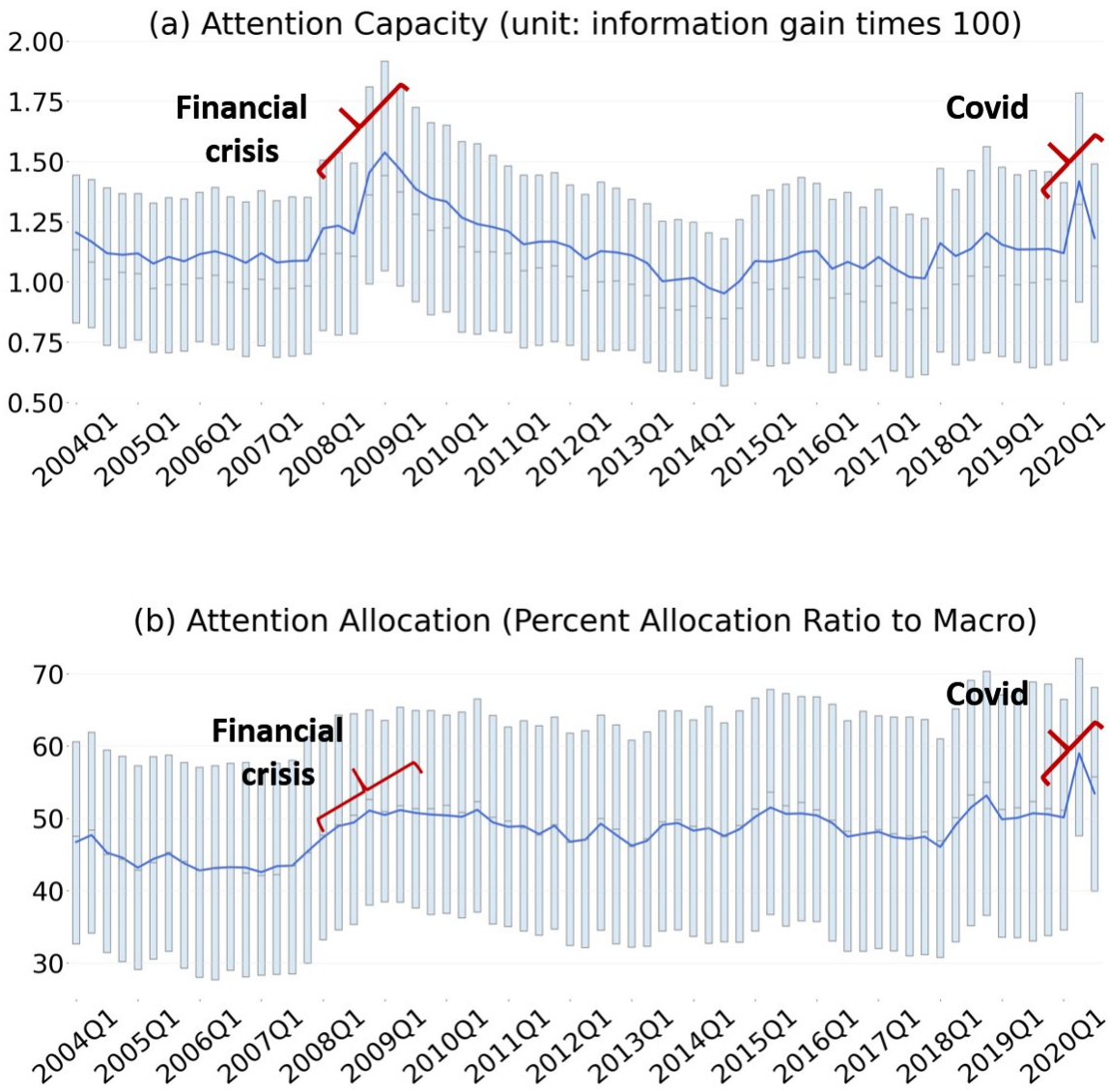


Note: This figure shows managers' attention to macroeconomic and firm-specific conditions. The box-whisker plots represent the distribution of the firm-level attention in each quarter. I only present the second and third quartile for a clearer presentation of the variation. The complete version is shown in the Appendix A. The line plot shows the aggregated attention.

Table 3 presents the correlation matrix between managerial attention and other firm-level variables.

I conclude that the determination of executives' attention is as follows:

Figure 2: Aggregated Executive Managers' Attention Capacity and Allocation, 2004Q1 – 2020Q3



Note: This figure shows the managers' attention capacity and attention allocation. The box-whisker plots represent the distribution of the firm's attention in each quarter. The line plot shows the aggregated attention.

1. Managerial attention capacity (hereafter AC) and attention allocation (hereafter AA) toward macroeconomics are counter-cyclical, as macroeconomics news is more salient in a recession than in an expansion. See Figure A.2 (a).

2. AC and AA are size-dependent. Large firms operate business in different states and even different countries; thus, they are more exposed to macroeconomic fluctuations than smaller firms. See Figure A.2 (b).

Table 3: Variable Correlation Matrix

	Leverage(market)	Leverage(book)	AttenCapacity	AttenAllocation
Firm Size	0.32	0.36	0.18	0.10
Profitability	0.06	0.07	0.18	0.10
Market-to-Book	0.04	0.36	-0.02	-0.03
Tangibility	0.37	0.27	0.15	-0.07
Leverage(market)			0.22	-0.09
Leverage(book)	0.79		0.15	-0.06
Real GDP Growth Rate	-0.03	-0.01	-0.06	-0.04

Note: This table presents correlation. All values are significant at the 1% level.

3. For similar reasons, financially unconstrained firms have higher AC and AA because they attend the public bond market and are more exposed to common shocks than financially constrained firms[21]. See Figure A.3 (a).

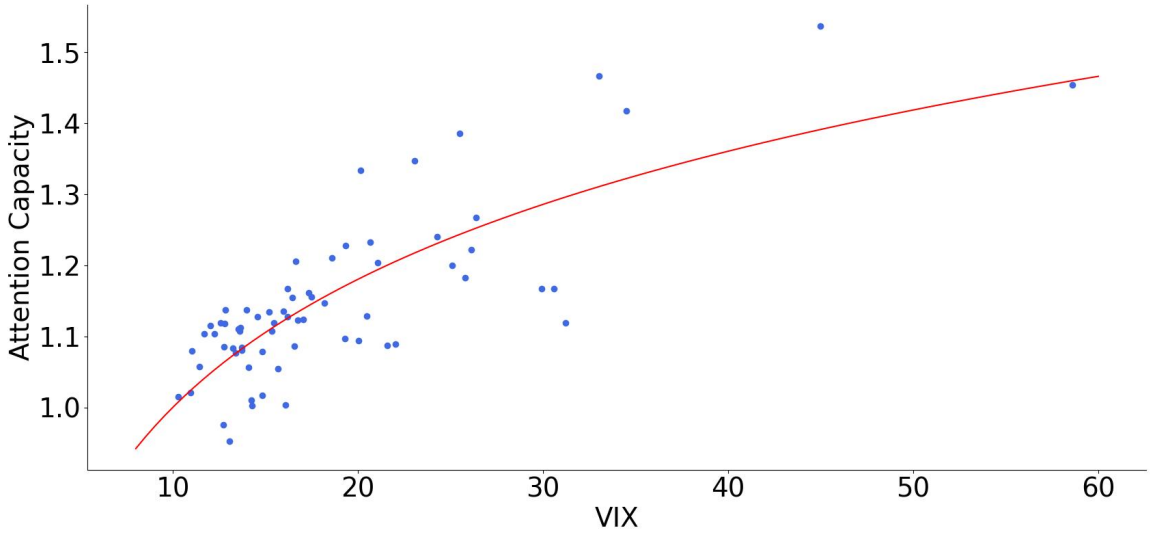
4. AC and AA are higher for firms with higher profitability. Because it is costly to understand macroeconomic news and policies, more profitable firms will be more likely to afford the expenses, such as hiring an economist as a consultant and purchasing media services. See Figure A.3 (b).

Whether financially constrained firms or unconstrained firms pay more attention to macroeconomics is ambiguous. There are two reasons with opposite directions. First, financially unconstrained firms are usually larger firms and can afford to learn more about economic perspectives. Second, financially constrained firms act more aggressively in obtaining inexpensive credits during expansion and choose to default during economic contractions. For this reason, financially constrained firms should also have incentives to pay attention to business cycles. Without a measurement of attention, the overall effect is unclear. Figure A.3 (a) shows that the first effect dominates.

Extending the theory of RI, I treat attention capacity as a function of overall uncertainty. In Section 1.4, I provide an explicit expression of attention capacity as a function of overall uncertainty. Here, I present a plot of aggregate attention capacity and a fitted function of Equation (1.36), $\kappa_t = \kappa_0 + \theta log(\sigma_{x,t})$. Figure 1.3 shows the aggregated attention capacity in response to the VIX.

[21]In a later section, I define financially constrained firms as those with bond ratings, while financially unconstrained firms do not have bond ratings

Figure 3: Aggregated Attention Capacity and A Fitted Line, 2004Q1 – 2020Q3



Note: These dots show a manager's attention capacity at the aggregate level. The red line shows the fitted line of Equation (1.36), $\kappa_t = 1.0 + 0.26 \times log(\sigma_{x,t})$. The vertical axis shows the aggregated attention capacity of my measurement. The horizontal axis shows the VIX.

2.10 Executives' Attention is different from the Business Cycles

From the previous analysis, I presented that the attention capacity can be driven by the business cycle. A natural concern of the attention measurement using the earnings call transcripts and natural language analysis is whether the measurement is just a proxy of macroeconomics. Using a simple ordinary least squares (OLS) of the attention measurements on the macroeconomic variables, GDP growth rate and VIX, I show in Table 4 that the attention measurements are distinct from the business cycles. Columns (1) and (2) show that the real GDP growth rate and VIX cannot explain all of the variation in the attention measurements.

I also present the timeseries of aggregated residuals from columns (1) column (2) in Figure A.4.

Table 4: Executives' Attention is Different from Business Cycles

	(1) Attention Capacity	(2) Attention Allocation
Real GDP	-0.0016^{***}	-0.0462^{***}
Growth	(0.00020)	(0.0070)
VIX	-0.0016^{***}	0.1651^{***}
	(0.00016)	(0.00545)
Constant	0.9462^{***}	45.397^{***}
	(0.00332)	(0.11500)
Firm Fixed Effect	YES	YES
Observations	125,244	125,244
Adjusted R^2	0.57	0.49

Note: This table presents the OLS regression of Attention Capacity and Attention Allocation on macroeconomic variables. The adjusted R^2 shows that the macro variables cannot fully explain executive attention.

3. Empirical Analysis

3.1 Data and Sample Selection

The primary sample includes firms in the quarterly Compustat database. I first restrict the sample to the firms that are listed on the major U.S. Stock Exchanges—the New York Stock Exchange (NYSE), and the National Association of Securities Dealers Automated Quotation (NASDAQ). I then exclude firms that are in Finance, Insurance, and Real Estate (SIC Codes 6000-6799), regulated division (SIC Codes 4000-4999) and Non-classifiable division(SIC Codes 9900-9999). Table A.1 provides more information on the SIC codes and corresponding divisions. I further drop the firms that have been in business for fewer than two years (eight quarters) as young firms have different financing policies. Finally, to mitigate the effect of outliers and eradicate errors in the data, I trim all variables at the upper and lower 0.5 percentiles. The earnings call transcripts were obtained from the FactSet database and written in English. When indexing the quarter of each call transcript file, I use the quarter when the call happens instead of the quarter to which the discussion applies. In this way, each transcript documents the C-Suite's belief of that time with less than one quarter forward-looking horizon. After merging the two databases, the sample consists of 127,678 documents covering the period from 2004Q1 to

2020Q3 for 3481 firms.

Following Welch (2011), I define financial debt (FD) over capital (CP) as the leverage ratio, where capital equals financial debt plus equity. Welch (2011) points out that the widely-used leverage ratio defined as financial debt over total assets is biased, as this definition ignores the role of non-financial liabilities. He argues that when using FD over total Asset (AT) as the leverage ratio, the leverage ratio becomes lower when a company has more equity, and when it has more non-financial liabilities. In effect, non-financial liabilities are counted the same as equity. Under this definition, there are two ways to define capital: book value of capital (BCP) and market value of capital (MCP). Other variables are shown in Table 1.5. Table 1.6 shows the summary statistics of the variables.

Table 5: Variable Construction Using the Compustat Sample

Variable Name	Variable Construction
Financial debt (FD)	long-term debt (DLTTQ)+debt in current liabilities (DLCQ)
Market value of capital(MCP)	Financial debt (FD) + market value of equity (MEQ)
Market value of equity (MEQ)	Close price (PRCCQ) × common share outstanding (CSHOQ)
Book value of capital (BCP)	Financial debt (FD) + book value of equity (BEQ)
Book value of equity (BEQ)	Stock-holders equity (SEQQ) + non-controlling interests (MIBTQ)
Firm size	log(assets(ATQ)), where assets are deflated by the GDP deflator
Profitability	Operating income before depreciation(OIBDPQ)/ assets (ATQ)
Market-to-Book ratio	Market value of equity (MEQ)/ book value of equity (BEQ)
Tangibility	Net property plant and equipment (PPENTQ)/ asset (ATQ)
AttentionToMacro	Author calculation
AttentionToFirm	Author calculation
AttentionCapacity	(AttentionToMacro + FirmAttention)*100
AttentionAllocation	((AttentionToMacro*100)/AttentionCapacity)*100

Note: The capitalized abbreviations in parenthesis follow the Compustat mnemonics when not otherwise defined. The definition of the leverage follow Welch (2011) and his website (the part of Notes on Debt Ratios). In Compustat raw data; I treat negative DLC as a missing value (na). These firm characteristics are commonly used in corporate finance literature.

Figure A.5 shows the industry distribution of the sample.

Table 6: Variable Definition and Transformation

Variable	Transformation	Mean	Standard Error	Median
Leverage(book)	FD[1] /BEQ[2]	0.32	0.28	0.29
Leverage(market)	FD/MEQ	0.19	0.20	0.13
Firm Size	$log(bookassets^3)$	9.20	1.77	0.75
Profitability		0.02	0.05	0.03
Tangibility		0.23	0.23	0.15
Market-to-Book	MEQ/BEQ	9.09	33.76	2.53
ATM	ATM times 100	0.59	0.49	0.47
ATF	ATF times 100	0.55	0.34	0.48
AttentionCapacity		1.14	0.64	1.03
AttentionAllocation		48.42	21.15	48.94

Note: 1. FD stands for Financial Debt; 2. BEQ is the book value of equity = $stockholders'equity + noncontrolling$; 3. deflated with GDP deflator.

3.2 Variance Decomposition

To find the dominance of the firm-level leverage changes, I decompose the variation in leverage changes into its common (aggregate), industrial and idiosyncratic components using the panel variance decomposition methods[22]. The variance decomposition follows a two-stage panel regression strategy. At the first stage, the aggregate component is uncovered by regressing the market leverage ratio (or leverage ratio growth rate) on time dummies and clustering standard errors at the firm level. At the second stage, the regression takes the residual series from the first stage and regresses on the interaction of time and sector dummies. From the second stage, the residual series are separated into a sector (SIC division) component and an idiosyncratic component. The results show that the idiosyncratic component is the most volatile. The relative standard deviation of the idiosyncratic component (0.20) is 5 times larger than that of the aggregate component (0.04) and 6.7 times larger than that of the sector-specific component (0.03). This further suggests that the aggregate component and the sector-specific component play a similar role. The literature agrees that industry characteristics can play an important role in explaining corporate leverage. This gives me the guidance in designing the role of macroeconomy and sector in the empirical analysis.

I applied the same variance decomposition exercise with the manager's attention to

[22]It was proposed by Carlsson and Skans (2012) and then used in Meyer et al. (2021). Lemmon et al. (2008) made a similar decomposition for firm-level leverage ratio change.

macro-conditions. The standard deviation of the idiosyncratic component (0.005) is 5.5 times that of the aggregated component (0.0009), and is 10 times than sector component.

Table 7: Variation Decomposition of the Executive Attention

	Leverage (market)	Leverage (book)	Attention Capacity	Attention Allocation
size	0.32	0.34	0.19	0.09
Probability	0.05	0.04	0.15	0.07
Market to Book	-0.01	0.11	-0.01	-0.01
Tangibility	0.38	0.27	0.15	-0.08
Leverage(market)			0.23	-0.10
Leverage(book)			0.15	-0.06
GDP	-0.04	-0.01	-0.06	-0.04
VIX	0.09	0.01	0.14	0.07

Note: This table presents correlation. All values are significant at 1% level.

The manager's attention capacity is counter-cyclical and size-dependent. Larger firms have more financial capacity to afford more information toward both macroeconomic and idiosyncratic shocks. The counter-cyclical pattern in the managers' attention capacity is mainly driven by their attention to macroeconomics. The coronavirus pandemic triggered more attention to macroeconomics than the 2008 Financial Crisis. The 2008 Financial Crisis triggered more attention to firm-specific issues than the coronavirus pandemic. There is no cyclical pattern of attention to idiosyncratic shocks. The coronavirus pandemic brings more common shocks than idiosyncratic shocks. Perhaps firms with higher exposure to macroeconomics will tend to pay more attention to macroeconomics.

3.3 C-Suite's Attention as a Factor of Leverage Dynamics

The variations and dynamics in a firm's leverage ratio have not been well-explained (Graham and Leary, 2011). This section aims at introducing managers' attention capacity and attention allocation as two important factors in a firm's leverage ratio.

$$leverage_{i,t} = \delta_i + \delta_t + \alpha_1 \times AttentionCapacity_{i,t} + \alpha_2 \times AttentionAllocation_{i,t} + \gamma \times Z_{i,t} + \epsilon_{i,t} \quad (9)$$

where $leverage_{i,t}$ is market leverage, and δ_i and δ_t are firm fixed effect and time-fixed effect. $Z_{i,t}$ is a vector of control variables, including firm size, profitability, market-to-book ratio, and tangibility. α_1 and α_2 are the constant coefficients of the two attention measurements. γ is a vector of coefficients of the control variables.

Table 1.8 presents the strong statistical evidence using the firm-level panel data. Comparing all eight columns, the results show that at the firm-level attention capacity has a significantly positive effect on the market leverage ratio. The attention allocation toward macroeconomics has a significantly negative effect on the firm-level leverage ratio. Both results hold even after controlling for firm characteristics, time, and firm fixed effects, comparing columns (4) and (6). By including attention capacity and attention allocation, I obtain the regression with the best adjusted R-square, shown in column (6). My result is still robust and significant after considering the business cycle, measured by the real GDP growth rate and VIX.

To interpret the magnitudes of attention capacity and allocation, consider Column (8). The coefficient on the attention capacity says, if the attention capacity increases by one standard deviation, the leverage rate increases 3.26%, considering other firm-level characteristics and business cycle variables. The coefficient on the attention allocation says, if the attention allocation toward macroeconomics increases by one standard deviation, the leverage decreases 23.68%. The magnitude difference brought by attention capacity and attention allocation may look very significant. However, the dynamics of attention capacity and attention allocation are correlated. Only looking at the coefficients is not enough to disentangle this relationship. I will use a theoretical model to demonstrate the relationship, considering the uncertainty changes from both macroeconomics and firm-specific issues.

The results suggest that a manager's attention to either macroeconomics and firm-specific issues has both substitution or scale effects on the leverage ratio. When a manager pays attention to macroeconomics, the attention capacity increases, motivating more information collection. Higher information volume will help a manager make better decisions (scale effect). Simultaneously, paying attention to macroeconomics may distract a manager from focusing on other issues important for the firm.

Table 8: Panel Regression, Leverage and Manager's Attention

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Attention Capacity		1.69***		2.01***		1.93***	2.79***	2.09***
		(0.07)		(0.07)		(0.07)	(0.07)	(0.07)
Attention Allocation			−5.53***	−6.39***		−6.11***	−4.06***	−4.77***
			(0.21)	(0.21)		(0.20)	(0.21)	(0.20)
Firm Size					4.29***	4.34***	5.93***	6.07***
					(0.07)	(0.07)	(0.07)	(0.07)
Profitability					−64.1***	−62.5***	−69.5***	−67.9***
					(1.13)	(1.12)	(1.15)	(1.14)
Market-to-Book Value					0.01***	0.01***	0.02***	0.02***
					(0.00)	(0.00)	(0.00)	(0.00)
Tangibility					23.8***	23.9***	30.0***	28.7***
					(0.51)	(0.51)	(0.51)	(0.51)
Real GDP Growth Rate							−0.10***	−0.001
							(0.00)	(0.01)
VIX								0.22***
								(0.00)
Constant	19.3***	17.4***	22.0***	20.1***	−24.7***	−24.4***	−42.2***	−46.5***
	(0.03)	(0.09)	(0.10)	(0.12)	(0.69)	(0.70)	(0.63)	(0.63)
Time Fixed Effect	YES	YES	YES	YES	YES	YES	NO	NO
Firm Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Observations	124617	124617	124617	124617	120444	120444	120444	120444
Adjusted R^2	0.75	0.75	0.75	0.75	0.76	0.77	0.75	0.76

Note: Standard errors in parentheses. *** represents $p < 0.01$. I present the coefficient of market-to-book value as 100 times the original values. The attention allocation is in decimal format instead of a percentage for coefficient presentation purpose. Controlling for sector-fixed effect will result in very similar results, see Table A.4.

The interaction of macro-news versus micro-news, and how it affects an agent's decision, has not yet been developed in the corporate finance field. In recent investor behavior literature,Peng and Xiong (2006) propose that investors see the macro-news and firm-level news as substitutes, and they process macro and sector news first, then turn to firm-specific information. Hirshleifer and Sheng (2021) also find that macro- news and micro-news can be complementary.

3.4 Executives' Attention as a Predictor of Leverage Ratio

Intuitively, executives first gather information about the macroeconomic and firm-specific issues, then make financial decisions. Based on this analysis, executives' attention should be a leading indicators of the financial decisions. Thus, the second question I ask is whether the attention capacity and attention allocation can predict future leverage ratio. Before testing this question, it is worthy to mention that firm-level leverage is very persistent, shown in Table 1.9 Column (1) where I regress leverage on one-step lag of leverage, the adjusted R-square is 0.95.

To investigate if the attention measurements have prediction power, I tested the lags of attention capacity and attention allocation. Using AIC, BIC test, I found that only three lags of the two attention measurements have prediction power. Column (2) shows that both attention measurements have prediction power of the level of leverage three steps ahead. I further tested how can the attention measurements can predict the changes in the leverage, I regress $\Delta leverage_t$ on $\Delta leverage_t$, $\Delta leverage_{t-1}$, $\Delta AttentionCapacity_{t-1}$, $\Delta AttentionAllocation_{t-1}$, and $\Delta AttentionCapacity_{t-2}$. The results are presented in Columns (3), (4) and (5). $\Delta AttentionCapacity_{t-1}$, and $\Delta AttentionCapacity_{t-2}$ show significant prediction power.

Table 9: Manager Attention Predicts Leverage Ratio

	(1) $leverage_t$	(2) $leverage_t$	(3) $\Delta leverage_t$	(4) $\Delta leverage_t$	(5) $\Delta leverage_t$
$Leverage_{t-1}$	0.89***	0.89***			
	(0.001)	(0.002)			
$\Delta Leverage_{t-1}$					−0.04***
					(0.003)
Attention $Capacity_{t-3}$		−0.18***			
		(0.04)			
Attention $Allocation_{t-3}$		0.23**			
		(0.11)			
$\Delta AttenCapacity_t$			0.24***		
			(0.03)		
$\Delta AttenAllocation_t$			−0.35***		
			(0.10)		
$\Delta AttenCapacity_{t-1}$				0.09***	0.10***
				(0.04)	(0.04)
$\Delta AttenCapacity_{t-2}$				0.16***	0.16***
				(0.04)	(0.04)
$\Delta AttenAllocation_{t-1}$				−0.08	−0.07
				(0.10)	(0.10)
Constant	2.38***	2.53***	0.29***	0.29***	0.31***
	(0.03)	(0.07)	(0.01)	(0.02)	(0.02)
Time Fixed Effect	YES	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES	YES
Observations	116782	113727	116782	104674	104542
Adjusted R^2	0.95	0.95	0.08	0.09	0.09

Note: Standard errors in parentheses. *** represents $p < 0.01$. The attention allocation is in decimal format instead of a percentage for coefficient presentation purpose.

3.5 Executives' Attention as an Amplifier of Business Cycles

Many evidence points out that the economic state affects the firm-level leverage ratio. However, the channels through which the business cycle transmits a firm's capital structure are still underdeveloped. I demonstrate that executive managers' attention can amplify the effect of the business cycle on a firm's financial decisions. To uncover this relationship, I add interaction terms of attention capacity times real GDP growth rate and attention allocation times the VIX into the baseline Equation (1.9).

$$
\begin{aligned}
leverage_{i,t} = \delta_i + \alpha_1 \times AttentionCapacity_{i,t} + \alpha_2 \times AttentionAllocation_{i,t} + \\
\beta_1 \times VIX_t + \beta_2 \times VIX_t \times AttentionCapacity_{i,t} \\
+ \beta_3 \times VIX_t \times AttentionAllocation_{i,t} + \gamma \times Z_{i,t} + \epsilon_{i,t}
\end{aligned} \tag{10}
$$

where $leverage_{i,t}$ is market leverage, and δ_i is the firm-fixed effect. $Z_{i,t}$ is a vector of control variables, including firm size, profitability, market-to-book ratio, and tangibility.

In Table 1.10, column (3) shows that the interaction term of attention capacity and VIX is negative. This suggests that when the VIX is negative, the firm-level leverage increases, and more than half of the effect works through the attention capacity channel. When executive managers are rising awareness of these uncertainties, they tend to take actions to offset them. Here, the action is to increase the leverage ratio to cope with economic downturns. This acts as the amplifier of business cycles. Column (4) shows that the interaction term of attention allocation and real GDP growth rate is positive. It suggests that when the real GDP growth rate is negative, paying attention to macroeconomics can distract managers who should evaluate what is a proper leverage ratio that includes rising credit risk. Managers may downplay the effect of firm-specific conditions and choose to lower the leverage ratio.

Table 10: Panel Regression, Manager's Attention as An Amplifier of the Business Cycle on Leverage

	(1)	(2)	(3)
Attention Capacity	2.09***	1.24***	2.12***
	(0.07)	(0.13)	(0.07)
Attention Allocation	−4.77***	−4.70***	−0.33
	(0.20)	(0.21)	(0.41)
Firm Size	6.07***	6.07***	6.08***
	(0.07)	(0.07)	(0.07)
Profitability	−67.9***	−67.9***	−67.7***
	(1.13)	(1.13)	(1.13)
Market-to-Book Value	0.02***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)
Tangibility	28.7***	28.7***	28.8***
	(0.51)	(0.51)	(0.51)
VIX	0.22***	0.17***	0.35***
	(0.00)	(0.01)	(0.01)
Attention Capcacity × VIX		0.04***	
		(0.01)	
Attention Allocation × VIX			−0.24***
			(0.02)
Constant	−46.5***	−45.4***	−48.9***
	(0.63)	(0.64)	(0.65)
Time Fixed Effect	YES	NO	NO
Firm Fixed Effect	YES	YES	YES
Observations	120444	120444	120444
Adjusted R^2	0.76	0.76	0.76

Note: Standard errors in parentheses.***$p < 0.01$. I present the coefficient of market-to-book value as 100 times the original values. The attention allocation is in decimal format instead of percentage for coefficient presentation purpose.

3.6 Robustness Checks

I apply a series of robustness checks in this section to investigate the heterogeneity due to firm-level characteristics. I first investigate whether the empirical results still hold for small firms, to test whether the careful speech engineering biases the attention measurements. I further consider the liquidity supply faced by individual companies. The third part includes the studies of cyclical and non-cyclical industries. (extend the writing)

3.6.1 Does speech engineering affect the measurements?

A common concern of using the quarterly earnings call transcripts is whether the speech at the earnings call reflects the executive managers' real thoughts. Public listed firms have incentives to hide what's bad for the company and try making the company's financial performance look as good as possible. This paper acknowledges this shortcoming. Indeed, all research using surveys as well as text-analysis encounter similar shortcomings. However, bad news and even financial misconduct do not necessarily have a material impact on the financial performance of public listed companies. Generally, big firms more tend to hire and afford consultants to polish their public speech, such as the earnings call. Therefore, small firms that present similar results would provide evidence of this view.

Table 11: Manager's Attention to Firm-level Leverage, by Firm size

	(1) All Samples	(2) Big Firms	(3) Small Firms
Attention Capacity	1.94*** (0.07)	1.80*** (0.10)	1.74*** (0.10)
Attention Allocation	−5.69*** (0.21)	−6.75*** (0.30)	−4.53*** (0.26)
Firm Size	4.34*** (0.07)	4.23*** (0.22)	3.48*** (0.11)
Profitability	−59.2*** (1.13)	−144.1*** (2.27)	−33.7*** (1.37)
Market to Book Value	0.015*** (0.00)	0.009*** (0.00)	0.013*** (0.00)
Tangibility	23.4*** (0.52)	23.6*** (0.75)	27.7*** (0.73)
Constant	−24.7*** (0.70)	−20.1*** (1.40)	−19.0*** (0.86)
Time Fixed Effect	YES	YES	YES
Firm Fixed Effect	YES	YES	YES
Observations	114,923	59,146	61,229
Adjusted R^2	0.76	0.79	0.73

Note: Standard errors in parentheses. *** indicates $pvalue < 0.01$. I present the coefficient of market-to-book value as 100 times the original values. The attention allocation is in decimal format instead of percentage for coefficient presentation purpose.

3.6.2 Role of Financial Constraints

To categorize firms into financially constrained and financially non-constrained groups, I look at whether a firm has access to the public debt market. Specifically, I use the bond rating from S&P 500[23]. I then merged the data with the accounting data from Compustat using the firm's stock ticker, resulting in 114,923 observations. I ran the same regression with the financially constrained group and the financially unconstrained group separately. Table 12 presents the results and they are robust across the whole sample and groups with different liquidity.

Column (2) shows that with better liquidity, a firm chooses to have a higher leverage ratio. To further compare the financially constrained and unconstrained group, I separate the sample companies into two groups and present the exercise results in columns (3)

[23]The data are obtained from the WRDS Bond Returns database. I choose the rating from S&P 500 instead of Moody's and Fitch, because of data availability.

and (4) separately. While it yields a robust result, the coefficients also show that financially unconstrained firms are more affected by attention allocation more. Financially constrained firms are more affected by attention capacity more.

Table 12: Manager's Attention to Firm-level Leverage, Considering Liquidity

	(1)	(2)	(3)	(4)	(5)
	All Samples	Not Financially Constraint	Financially Constraint	Not Financially Constraint low attention capacity	Not Financially constraint high attention capacity
Attention	1.94***	1.47***	1.92***	2.97***	0.90***
Capacity	(0.07)	(0.15)	(0.08)	(0.50)	(0.21)
Attention	−5.69***	−6.72***	−5.00***	−5.66***	−6.88***
Allocation	(0.21)	(0.48)	(0.22)	(0.66)	(0.72)
Firm	4.34***	3.68***	3.93***	3.57***	4.34***
Size	(0.07)	(0.22)	(0.08)	(0.31)	(0.33)
Profitability	−59.2***	−127.5***	−49.5***	−110.0***	−143.1***
	(1.13)	(3.53)	(1.17)	(4.66)	(5.37)
Market to	0.015***	0.015***	0.013***	0.02***	0.014***
Book Value	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tangibility	23.4***	22.7***	23.0***	17.05***	26.14***
	(0.52)	(1.28)	(0.56)	(1.82)	(1.85)
Constant	−24.7***	−12.9***	−21.8***	−14.08***	−18.07***
	(0.70)	(2.51)	(0.72)	(3.49)	(3.78)
Time Fixed Effect	YES	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES	YES
Observations	114923	20585	94152	9871	10610
Adjusted R^2	0.76	0.80	0.76	0.80	0.82

Note: Standard errors in parentheses. *** indicates p value < 0.01. I present the coefficient of market-to-book value as 100 times the original values. The attention allocation is in decimal format instead of percentage for coefficient presentation purpose.

3.6.3 Cyclical vs Non-cyclical Industry

Empirical results in Section 3 documents that the business cycle plays an important role in leverage and executive attention. To investigate the heterogeneity of cyclical sensitivity, I separated the full sample into two parts, cyclical and non-cyclical industries. For the eleven sectors recognized in Table A.1, I assign Construction, Manufacturing,

Wholesale Trade, and Retail Trade as cyclical sensitive sectors[24]. Other sectors were not cyclically sensitive sectors. When a firm is more cyclically sensitive, the managers pay more attention to macroeconomics.

Table 13: Manager's Attention to Firm-level Leverage, Considering Cyclical Sensitivity

	(1) All Samples	(2) Cyclical Sensitive	(3) Not Cyclical Sensitive
Attention Capacity	2.79***	3.06***	2.27***
	(0.07)	(0.09)	(0.12)
Attention Allocation	−4.06***	−4.73***	−2.96***
	(0.21)	(0.26)	(0.35)
Firm Size	5.93***	6.52***	5.06***
	(0.07)	(0.09)	(0.10)
Profitability	−69.5***	−65.9***	−80.2***
	(1.15)	(1.36)	(2.16)
Market-to-Book Value	0.02***	0.02***	0.01***
	(0.00)	(0.00)	(0.00)
Tangibility	30.0***	32.9***	26.2***
	(0.51)	(0.67)	(0.81)
Real GDP Growth Rate	−0.10***	−0.10***	−0.10***
	(0.00)	(0.01)	(0.01)
Constant	−42.2***	−48.4***	−32.5***
	(0.63)	(0.82)	(1.01)
Time Fixed Effect	NO	NO	NO
Firm Fixed Effect	YES	YES	YES
Observations	120444	77481	42963
Adjusted R^2	0.75	0.72	0.79

Note: Standard errors in parentheses. *** indicates p value < 0.01. I present the coefficient of market-to-book value as 100 times the original values. The attention allocation is in decimal format instead of percentage for coefficient presentation purpose.

In Table 13, columns (2) and (3) present the empirical exercise in Equation (9) for the cyclically sensitive industries and cyclically insensitive industries. Both scale effect and substitute effects are robust. Comparing results of cyclically sensitive industries (column (2)) and cyclically insensitive industries (column (3)), managerial attention has greater effects on the leverage ratio for cyclically sensitive industries.

4. Theoretical Model

[24]This categorization is based on Berman and Pfleeger (1997).

The empirical results from Section 2 and section 3 indicate that executives' attention has non-trivial quantitative implications in financing decisions. To address the impact of information rigidity on a manager's financial decision, I introduce rational inattention (henceforth RI) into a contingent claims model with an optimal static capital structure. Following the established "noisy information model" proposed by Sims (2003, 2006, 2010), I assume that for a representative firm, the manager's attention capacity and attention allocation are endogenous. Specifically, I provide an explicit expression of attention capacity as a function of the overall uncertainty, which is a simple sum of uncertainty of macroeconomics and firm-specific issues. I further analysis how does uncertainty of either aspects influences the attention capacity and attention allocation.

RI has been well developed in macroeconomics and investment. Embedding RI in corporate finance is quite a challenge mainly due to, to my experience, the different statistics assumptions and the modeling complications in capital structure models. To merge the frameworks of RI and corporate finance, I first keep the assumption in baseline corporate finance model that the cash flow follows a Geometric Brownian Motion (GBM). This is the fundamental difference from the popular AR(1) assumption of shocks in RI. To keep the linear function of state variable, I assume that the cash flow consists of two independent components: macro and firm-specific components. To make this integration attempt straightforward, I apply an optimal static capital structure model under the contingent claims paradigm. The advantage of using this model provide two advantages. First, one can simply apply comparative statics to yield the differences between firm's decisions with perfect attention and with rational inattention. Second, I can examine the difference between liquidity default (financial constrained firms) and optimal default (financial unconstrained firms) two scenarios. In section 4.1, I introduce a new information decision process for managers. In section 4.2, I mainly constructs the framework of optimal static capital structure with standard corporate finance assumptions. For readers that are familiar with these model can jump to section 4.3. A manager's financing decision is setup into two steps. At the beginning of the period, the manager makes optimal information decision according to the information she gained from last period. In this step, the manager chooses attention capacity and allocate attention. At the end of the period, the manager makes optimal financing decisions using the attention capacity and attention allocation decisions made from step one.

4.1 Introducing Executive Attention Decisions

As in the classic real options investment model, a representative firm generate cash flow X at time t from the assets owned by the firm. I suppose the cash flow X consists

of macro and firm-specific components with a linear function:

$$X_t = logm_t + logf_t \tag{11}$$

where m_t represents the aggregate component of cash flows and f_t represents the firm-specific component of cash flows. Both components are stochastic GBMs and satisfy the following Stochastic Differential Equations (SDEs):

$$dm_t = \mu_m m_t dt + \sigma_m m_t dW_t^m. \tag{12}$$

$$df_t = \mu_f f_t dt + \sigma_f f_t dW_t^f. \tag{13}$$

where μ_m and μ_f are constant percentage drifts. σ_m and σ_f are constant percentage volatility. The drift terms are to model deterministic trends, while the volatility terms are to model a set of unpredictable events occurring during the motion. W_t^m and W_t^f are independent Brownian motions.

Given the arbitrary initial value m_0 and f_0, the above SDEs have analytic solutions (under the Ito's interpretation):

$$m_t = m_0 exp((\mu_m - \frac{\sigma_m^2}{2})t + \sigma_m W_t^m) \tag{14}$$

$$f_t = f_0 exp((\mu_f - \frac{\sigma_f^2}{2})t + \sigma_f W_t^f) \tag{15}$$

where m_0 and f_0 are the initial values of m_t and f_t. By writing it with a natural Lagrangian format, m_t and f_t can transform to:

$$logm_t = logm_0 + (\mu_m - \frac{\sigma_m^2}{2})t + \sigma_m W_t^m \tag{16}$$

$$logf_t = logf_0 + (\mu_f - \frac{\sigma_f^2}{2})t + \sigma_f W_t^f \tag{17}$$

where $logm_t \sim N(logm_0 + (\mu_m - \frac{\sigma_m^2}{2}t), \sigma_m^2 t)$, and $logf_t \sim N(logf_0 + (\mu_f - \frac{\sigma_f^2}{2}t), \sigma_f^2 t)$. Combining the macro and the firm-specific components, I write the cash flow of the firm as the equation (1.18). The distribution of X_t can be derived accordingly: $N(log(X_0) + (\mu_x - \frac{\sigma_x^2}{2})t, \sigma_x^2 t)$.

$$X_t = logm_t + logf_t = log(X_0) + (\mu_x - \frac{\sigma_x^2}{2})t + \sigma_x W_t^{x25} \tag{18}$$

---

[25] $X_0 = m_0 f_0$, $\sigma_x = \sqrt{\sigma_m^2 + \sigma_f^2}$, $\mu_x = \mu_m + \mu_f$. See the calculation in Appendix B.

I focus on executive information decisions. Specifically, at the beginning of each period t, managers make the optimal information decision by deciding the attention capacity and attention allocation. For a representative firm f, the firm is exposed to both macroeconomic (m_t) and firm-specific (f_t) shocks. Following information rigidity pioneered by Sims (2003), I assume managers observe the macroeconomic and the firm-specific components with noise. Suppose $s_{m,t}$ ($s_{f,t}$) is the observed macroeconomic (firm-specific) component at time t about $t+1$ dynamics:

$$s_{m,t} = logm_{t+1} + \epsilon_{m,t} \tag{19}$$

$$s_{f,t} = logf_{t+1} + \epsilon_{f,t} \tag{20}$$

where $\epsilon_{m,t} \sim N(0, \eta^2_{m,t})$, and $\epsilon_{f,t} \sim N(0, \eta^2_{f,t})$ are *iid* idiosyncratic shock and are independent from the fundamental shocks (m_{t+1}, f_{t+1}) tha hit the economy at the time *t+1*. When an executive pay more attention to a factor, the executive gains more information about the factor and the signal of this factor becomes more precise. That is $s_{m,t}$ becomes closer to $logm_{t+1}$. $\epsilon_{m,t}$ and $\epsilon_{f,t}$ are endogenous noise determined by the executive's finite attention capacity and attention allocation. Both the macro component process $logm_{t+1}$ and the noise follow Gaussian distribution; the joint distribution $s_{m,t}$ also follows Gaussian distribution $N(logm_0 + (\mu_m - \frac{\sigma^2_m}{2})t, \sigma^2_m(t+1) + \eta^2_{m,t})$. Similarly, the noisy signal for the firm component $s_{f,t}$ follows Gaussian distribution $N(logf_0 + (\mu_f - \frac{\sigma^2_f}{2})t, \sigma^2_f(t+1) + \eta^2_{f,t})$. Given the noisy signal $s_{x,t}$, a manager can update a belief about the cash flow according to the Bayes rule. The manager forms a posterior belief with the conditional distribution of the macro component $logm_{t+1}|s_{m,t} \sim N(\hat{m}_t, \hat{\omega}^2_{m,t})$, and the firm-specific component $logf_{t+1}|s_{f,t} \sim N(\hat{f}_t, \hat{\omega}^2_{f,t})$, where $\hat{m}_t$ and $\hat{f}_t$ are the conditional mean, and $\hat{\omega}^2_{m,t}$ and $\hat{\omega}^2_{f,t}$ are the conditional variance. According to the Bayes rule:

$$\frac{1}{\hat{\omega}^2_{m,t}} = \frac{1}{\sigma^2_m(t+1)} + \frac{1}{\eta^2_{m,t}} \tag{21}$$

$$\frac{1}{\hat{\omega}^2_{f,t}} = \frac{1}{\sigma^2_f(t+1)} + \frac{1}{\eta^2_{f,t}} \tag{22}$$

Recall the entropy of unconditional m_{t+1} is:

$$\mathcal{H}(m_{t+1}) = \frac{1}{2} log_2(2\pi e \sigma^2_m(t+1)) \tag{23}$$

The entropy of conditional $m_{t+1}|s_{m,t}$ is:

$$\mathcal{H}(m_{t+1}|s_{m,t}) = \frac{1}{2} log_2(2\pi e \hat{\omega}^2_{m,t}) \tag{24}$$

Thus, the amount of information contained in $s_{m,t}$ about m_{t+1} can be expressed by the reduction in the entropy of m_{t+1} after acknowledging $s_{m,t}$:

$$I(m_{t+1}; s_{m,t}) \equiv \mathcal{H}(m_{t+1}) - \mathcal{H}(m_{t+1}|s_{m,t}) = \frac{1}{2} log(\sigma_m^2(t+1)/\hat{\omega}_{m,t}^2) = \lambda_{m,t}\kappa_t \tag{25}$$

similarly, the amount of information contained in $s_{f,t}$ about f_{t+1} can be expressed by the reduction in the entropy of f_{t+1} after acknowledging about $s_{f,t}$:

$$I(f_{t+1}; s_{f,t}) \equiv \mathcal{H}(f_{t+1}) - \mathcal{H}(f_{t+1}|s_{f,t}) = \frac{1}{2} log(\sigma_f^2(t+1)/\hat{\omega}_{f,t}^2) = \lambda_{f,t}\kappa_t \tag{26}$$

where κ_t is the manager's information channel capacity (also called as attention capacity in Section 2 and 3). κ_t also imposes an upper bound on the manager's information flow, which is defined as the uncertainty reduction of the mutual entropy of historical information and new information. From Equations (21) and (22), the perceived variances of the macro component and the firm-specific component noises are:

$$\eta_{m,t}^2 = \frac{\sigma_m^2(t+1)}{e^{\lambda_{m,t}\kappa_t} - 1} \tag{27}$$

$$\eta_{f,t}^2 = \frac{\sigma_f^2(t+1)}{e^{\lambda_{f,t}\kappa_t} - 1} \tag{28}$$

Inspired by the empirical results, I assume the information capacity κ_t is variant instead of constant. As I assume the macro and firm-specific components of the managerial information decision of macro and firm-specific components are independent,

$$I(X_{t+1}; s_{x,t}) = I(m_{t+1}; s_{m,t}) + I(m_{t+1}; s_{m,t}) \leq \kappa_t \tag{29}$$

$$\lambda_{m,t}\kappa_t + \lambda_{f,t}\kappa_t \leq \kappa_t \tag{30}$$

$$\lambda_{m,t} + \lambda_{f,t} \leq 1 \tag{31}$$

After acquiring the noise signal, the manager updates his belief of the macro component $logm_{t+1}$ based on the Bayes rule with mean and variance of belief as:

$$\hat{m}_t = \bar{m}_t + (1 - e^{-\lambda_{m,t}\kappa_t})(s_{m,t} - \bar{m}_t)^{26} \tag{32}$$

$$\hat{\omega}_{m,t}^2 = \sigma_m^2(t+1)e^{-\lambda_{m,t}\kappa_t} \tag{33}$$

where $(1-e^{-\lambda_{m,t}\kappa_t})$ is the responsiveness of $\hat{m}_t$ to the signal, increases with both attention

[26] $\bar{m}_t = logm_0 + (\mu_m - \frac{\sigma_m^2}{2})t$

allocation rate $\lambda_{m,t}$ and attention capacity κ_t. Similar distribution can be found with the firm-specific component:

$$\hat{f}_t = \bar{f}_t + (1 - e^{-\lambda_{f,t}\kappa_t})(s_{f,t} - \bar{f}_t)^{27} \tag{34}$$

$$\hat{\omega}^2_{f,t} = \sigma^2_f(t+1)e^{-\lambda_{f,t}\kappa_t} \tag{35}$$

4.2 Executives' Information Decision

To make an efficient inter-temporal financing decision, the manager must determine the attention capacity first, then the attention allocation to factors that can affect the decision. I assume the attention capacity as a function of the cash flow standard deviation:

$$\kappa_t = \kappa_0 + \theta log(\sigma_{x,t}) \tag{36}$$

where $\kappa_0 > 0$ and $0 < \theta < 1$ adjusts the relative scale. $\kappa_0 > 0$ because intuitively, a manager should always be attentive to cash flow dynamic. $0 < \theta < 1$ because the attention capacity should also increases as cash flow variance increases, while the slope decreases.

The objective of a manager's information decision is to minimize the variance of his belief about each period's cash flow.

$$V_t = \min_{\lambda_{m,t},\lambda_{f,t}} Var_t(X_{t+1}|s_{m,t}, s_{f,t}) \quad = \min_{\lambda_{m,t},\lambda_{f,t}} \sigma^2_m(t+1)e^{-\lambda_{m,t}\kappa_t} + \sigma^2_f(t+1)e^{-\lambda_{f,t}\kappa_t} \tag{37}$$

The manager's information decisions can be further transformed problem into

$$V_t = \min_{\lambda_{m,t},\lambda_{f,t}} \sigma^2_m(t+1)e^{-\lambda_{m,t}\kappa_t} + \sigma^2_f(t+1)e^{-\lambda_{f,t}\kappa_t} \tag{38}$$

with three constraints:

$$\lambda_{m,t} + \lambda_{f,t} \leq 1 \tag{39}$$

$$0 \leq \lambda_{m,t} \leq 1 \tag{40}$$

$$0 \leq \lambda_{f,t} \leq 1 \tag{41}$$

Solving Equation (38) and Equation (39) with Lagrange multiplier gives:

$$\lambda_{m,t} - \lambda_{f,t} = \frac{2}{\kappa_t} log(\frac{\sigma_{m,t}}{\sigma_{f,t}}) \tag{42}$$

---

[27] $\bar{f}_t = log f_0 + (\mu_f - \frac{\sigma^2_f}{2})t$

$$\lambda_{m,t} = \frac{1}{2} + \frac{1}{\kappa_t} log(\frac{\sigma_{m,t}}{\sigma_{f,t}}) \tag{43}$$

$$\lambda_{f,t} = \frac{1}{2} - \frac{1}{\kappa_t} log(\frac{\sigma_{m,t}}{\sigma_{f,t}}) \tag{44}$$

This result indicates that a manager's attention allocation depends on the relative size of the standard deviation between the macro component and firm-specific component. A manager's attention allocation toward one component is positively correlated with the component's own variance. When the variance of the macro component increases, the manager increases the attention allocated to macroeconomics.

Meanwhile, equations (40)—(41) and (43)—(44) provide the binding of attention capacity via providing the constraints on the volatility. When σ_m and σ_f are constrained by maximum values σ_m^{max} or σ_f^{max}, the attention capacity κ_t has a maximum.

The manager's financing decision in the rise of macro volatility is a major concern in this paper. When macroeconomic volatility σ_m^2 increases while keeping the volatility of firm-specific component σ_f^2 constant, a manager's attention capacity κ_t first increases. The manager's attention to macroeconomic and firm-specific components can be described as:

$$AttentionToMacro_t(ATM_t) = \lambda_{m,t} \times \kappa_t = \frac{1}{2}\kappa_t + log\frac{\sigma_m}{\sigma_f} \tag{45}$$

$$AttentionToFirm_t(ATF_t) = \lambda_{f,t} \times \kappa_t = \frac{1}{2}\kappa_t - log\frac{\sigma_m}{\sigma_f} \tag{46}$$

where $\frac{1}{2}\kappa_t$ represents the scale effect and $log\frac{\sigma_m}{\sigma_f}$ represents the substitute effect[28]. As a result, a manager's attention to macroeconomics certainly increases, while the attention to firm-specific component remains uncertain. Both the first term $\frac{1}{2}\kappa_t$ and the second term $log\frac{\sigma_m}{\sigma_f}$ increase, and which term increase more requires further analysis. Taking the first derivative of ATF_t in response to σ_m yields:

$$\frac{\partial ATF_t}{\partial \sigma_m} = \frac{(\frac{\theta}{2} - 1)\sigma_m^2 - \sigma_f^2}{\sigma_m(\sigma_m^2 + \sigma_f^2)} \tag{47}$$

As $0 < \theta < 1$, $\frac{\partial ATF_t}{\partial \sigma_m} < 0$, suggesting that the net effect on attention to firm-specific issues is negative. To investigate the net substitute effect, one must focus on equation (43). Both (43) and (44) are binding by the range $[0, 1]$. I demonstrate and compare the scale effect and substitute effect with comparative statistics in section 4.4.

[28]See Appendix B for math details.

4.3 A Representative Firm's Optimal Financial Decision

In this section, I introduce the standard optimal static capital structure framework with contingent claim paradigm. This setup serves the second step of a manager's decision. I assume a firm's investment and financing decision are independent, so that cash flows are not affected by investment nor operating costs. The cash flow X_t then is equivalent to earnings before interest and taxes (EBIT). Assuming perpetuity cash flows, I calculate the equity value of an unleveraged firm at any time t as discounted cash flows after taxes:

$$S_t = \frac{(1-\tau)X_t}{r-\mu_x} \tag{48}$$

where τ is the tax rate charged as a fraction of a firm's EBIT. No income tax is considered.

Consistent with the trade-off theory, issuing corporate debt provides a "tax shield" to the company. The interest payments are considered as expenses that are excluded from the taxation. I assume a simple perpetual debt with a constant coupon flow c. The total gain from the tax benefits to debt thus is $\frac{\tau c}{r-\mu_x}$. The cost of issuing corporate debt is the default. I assume two different types of default plan: optimal default and liquidity default. The are also known as endogenous default and exogenous default. These two different default options represent two categories of firms that I would like to focus on in this paper: the firms without financial constraints and firms with financial constraints. This setup provides a natural comparison of the effect of limited attention and liquidity constraint and hence addresses the question of the degree of impact from attention side.

Because X_t is the only state variable, the two default options indicate different default thresholds, denoted as X_D. In the case of liquidity default, the company choose the default threshold $X_D = c$. In the case of optimal default, the company choose a threshold $X_D < c$. In both senarios, the companies choose to default when the cash flow reaches the threshold the first time from above. The managers determine the default threshold to maximize the equity value. The effective assumption here is that the equity holders have "deep pockets," meaning they can find other sources to provide liquidity to cover the coupon payments. In this case $X_D < c$. In the case of liquidity default, the default occurs when X_t becomes sufficiently low. I interpret this default time as the default threshold X_D equals the coupon payment c.

Considering an Arrow —Debreu claim at any time before the time of default, the value of the default as an option is:

$$A(X_t, X_D) = (\frac{X_t}{X_D})^{\xi_1} \tag{49}$$

where ξ_1 is the negative root of the fundamental quadratic equation:

$$\xi_1 = -\frac{1}{\sigma_x^2}(\mu_x - \frac{\sigma_x^2}{2} + \sqrt{(\mu_x - \frac{\sigma_x^2}{2})^2 + 2\sigma_x^2 r}) \tag{50}$$

For any date prior to default, the value of levered equity can be written as:

$$S(X_t) = (\frac{X_t}{r-\mu_x} - \frac{c}{r})(1-\tau) + A(X_t, X_D)(-\frac{X_D}{r-\mu_x} + \frac{c}{r})(1-\tau) \tag{51}$$

where in the equation, the first term $(\frac{X_t}{r-\mu_x} - \frac{c}{r})(1-\tau)$ represents the after-tax levered equity value in perpetuity when default does not happen. The second term $A(X_t, X_D)(-\frac{X_D}{r-\mu_x} + \frac{c}{r})(1-\tau)$ considers the scenario of default, when shareholders give up future cash flows in exchange for discontinuing interest payments. To find the optimal level of X_D, we apply the smooth-pasting condition:

$$\frac{\partial S(X_t)}{\partial X_t}|_{X_t = X_D} = 0 \tag{52}$$

By solving the condition equation, the optimal default boundary is:

$$X_D = \frac{\xi_1}{\xi_1 - 1}\frac{r-\mu_x}{r}c \tag{53}$$

Denote $\gamma_D = \frac{\xi_1}{\xi_1 - 1}\frac{r-\mu_x}{r}$, thus $X_D = \gamma_D c$. One can easily prove that $\xi_1 < 0$ and $\gamma_D < 1$. This indicates that with the default option, the manager chooses to keep the firm running with the cash flow less than the coupon payment c. The manager needs to find other financial sources to avoid default. Thus, one can interpret $\gamma_D = 1$ as the liquidation default case.

Given coupon c and default threshold X_D, the value of debt which applies liquidation in the case of default, is:

$$D(X_t) = \frac{c}{r} - A(X_t, X_D)\frac{c}{r} + A(X_t, X_D)(1-\alpha)(1-\tau)\frac{X_D}{r-\mu} \tag{54}$$

To interpret this equation, I suppose the first term $\frac{c}{r} - A(X_t, X_D)\frac{c}{r}$ as the perpetuity value of risk-free debt. The second term $A(X_t, X_D)(1-\alpha)(1-\tau)\frac{X_D}{r-\mu}$ is the percent value of interest payments that the debt-holders lose when the firm chooses to default. The last term represents the present value of assets that debt-holders recover in liquidation.

Under the framework of a static capital structure environment, the decision to issue debt is made only once, which is at date 0. Shareholders consider maximizing the total value of future equity and debt. Because this is a decision about committing ex ante to maximizing the firm value, shareholders will internalize the value of future debt-holders' claims. Thus, I define the firm value at date 0 as the sum of equity value at date 0 and the debt value at date 0: $V(X_0) = S(X_0) + D(X_0)$. Considering Equations (51) and (54), I can rewrite the firm value at date 0 as:

$$\begin{aligned} V(X_0) =& (\frac{X_0}{r-\mu_x} - \frac{c}{r})(1-\tau) + A(X_0, X_D)(-\frac{X_D}{r-\mu_x} + \frac{c}{r})(1-\tau) + \\ & \frac{c}{r} - A(X_0, X_D)\frac{c}{r} + A(X_0, X_D)(1-\alpha)(1-\tau)\frac{X_D}{r-\mu} \end{aligned} \tag{55}$$

To decide a financial structure aiming at maximizing the firm value, the shareholders need to choose an optimal coupon c:

$$\frac{\partial V(X_0)}{\partial c} = 0 \tag{56}$$

Solving this equation, the optimal coupon payment is:

$$c^* = \frac{1}{\gamma}[\frac{1}{1-\xi_1}\frac{\tau}{(1-\tau)\alpha\gamma\frac{r}{r-\mu_x} + \tau}]^{\frac{1}{\xi_1}} X_0 \tag{57}$$

Both empirical and theoretical research tend to use financial leverage rate upon cross-firm comparison because the coupon rate is related to the firm size and not interpreted as a main proxy for financial policy.

I apply quasi-market leverage ratio:

$$QML(X_t) = \frac{D(X_0)}{D(X_0) + S(X_t)} \tag{58}$$

4.4 Manager's Financing Decision Under Information Friction: Comparative Statics

A manager's posterior belief with the conditional distribution of the cash flow $X_{t+1}|s_{m,t}, s_{f,t} \sim N(\hat{X}_t, \hat{\omega}^2_{x,t})$. Because the macro component and firm-specific components

are independent[29],

$$\begin{aligned}\hat{X}_t &= \hat{m}_t + \hat{f}_t \\ &= \bar{m}_t + \bar{f}_t + (1 - e^{-\lambda_{m,t}\kappa_t})(s_{m,t} - \bar{m}_t) + (1 - e^{-\lambda_{f,t}\kappa_t})(s_{f,t} - \bar{f}_t) \\ &= \bar{X}_t + (1 - e^{-\lambda_{m,t}\kappa_t})(s_{m,t} - \bar{m}_t) + (1 - e^{-\lambda_{f,t}\kappa_t})(s_{f,t} - \bar{f}_t)\end{aligned} \tag{59}$$

$$\hat{\omega}^2_{x,t} = \sigma^2_m(t+1)e^{-\lambda_{m,t}\kappa_t} + \sigma^2_f(t+1)e^{-\lambda_{f,t}\kappa_t} \tag{60}$$

Recall that in Section 4.3, Equation (57) indicates the coupon payment under perfect information, where the unconditional distribution of X_{t+1}: $N(log(X_0)+(\mu_x-\frac{\sigma_x^2}{2})(t+1), \sigma_x^2(t+1))$[30]. Equation (1.50) indicates that ξ_1 is a function of cash flow's mean and variance. The conditional distribution of the cash flow indicates a lower variance than the unconditional case. However, the relative size of the conditional mean versus the unconditional mean is uncertain.

When considering the information friction, the dynamics of the optimal coupon payment becomes too complicated. It is not easy or straight forward to provide an analytical analysis. I use a comparative statics to demonstrate the dynamics. Figure 4 illustrates the comparative statics of managerial attention capacity and attention allocation. Equations (36), (43) and (44) indicates that the volatility of both macro and firm-specific components can determine a manager's attention capacity and allocation. Figure 5 demonstrate that given increases in macro uncertainty, the relative size of scale effect and substitute effect can be different. The attention capacity is binding, whereas the attention allocation ratio has upper and lower bindings. When the firm-specific is small, large macro uncertainty may only increase the attention capacity, while the attention allocation ratio to macro is fixed at 1. When firm-specific uncertainty is large, low macro uncertainty may only increase the attention capacity too. This well explains that despite the coefficient of attention allocation is larger than that of the attention capacity, the overall effect on leverage is still increasing. When the attention allocation ratio is not binding, the substitute effect is larger than the scale effect, which is not the case shown in the empirical facts.I also examine both components in Figure 6. The x axis represents for the volatility of the macro component, and the four line plots in each graph shows different levels of volatility of firm-specific components.

Figure 6 presents the comparative statics of the optimal static capital structure model under no attention (classic attention) and limited attention. The dotted blue line

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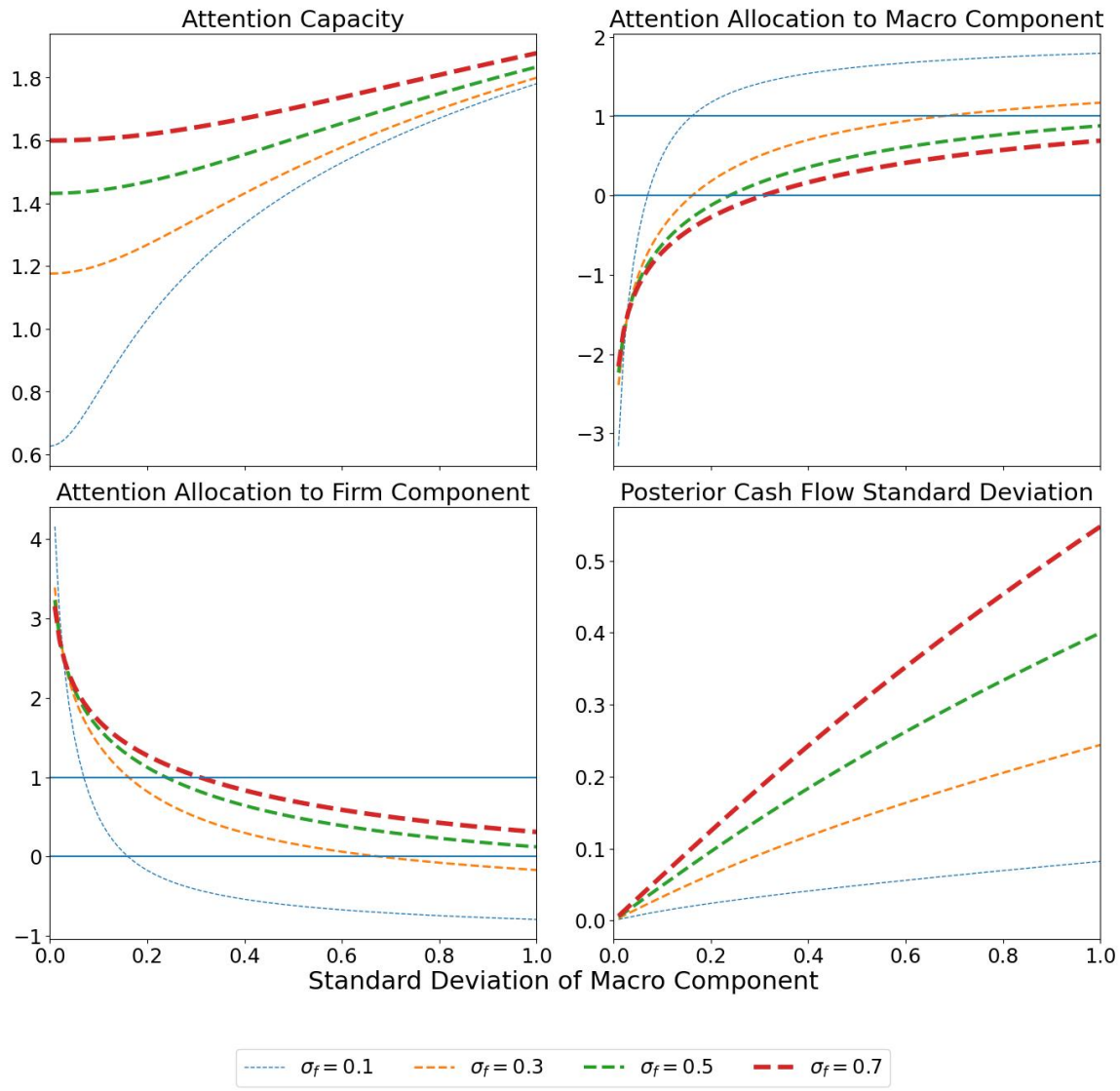
[29] $\bar{X}_t = logX_0 + (\mu_x - \frac{\sigma_x^2}{2})t$

[30] $X_0 = m_0 f_0$, $\sigma_x = \sqrt{\sigma_m^2 + \sigma_f^2}$, $\mu_x = \mu_m + \mu_f$

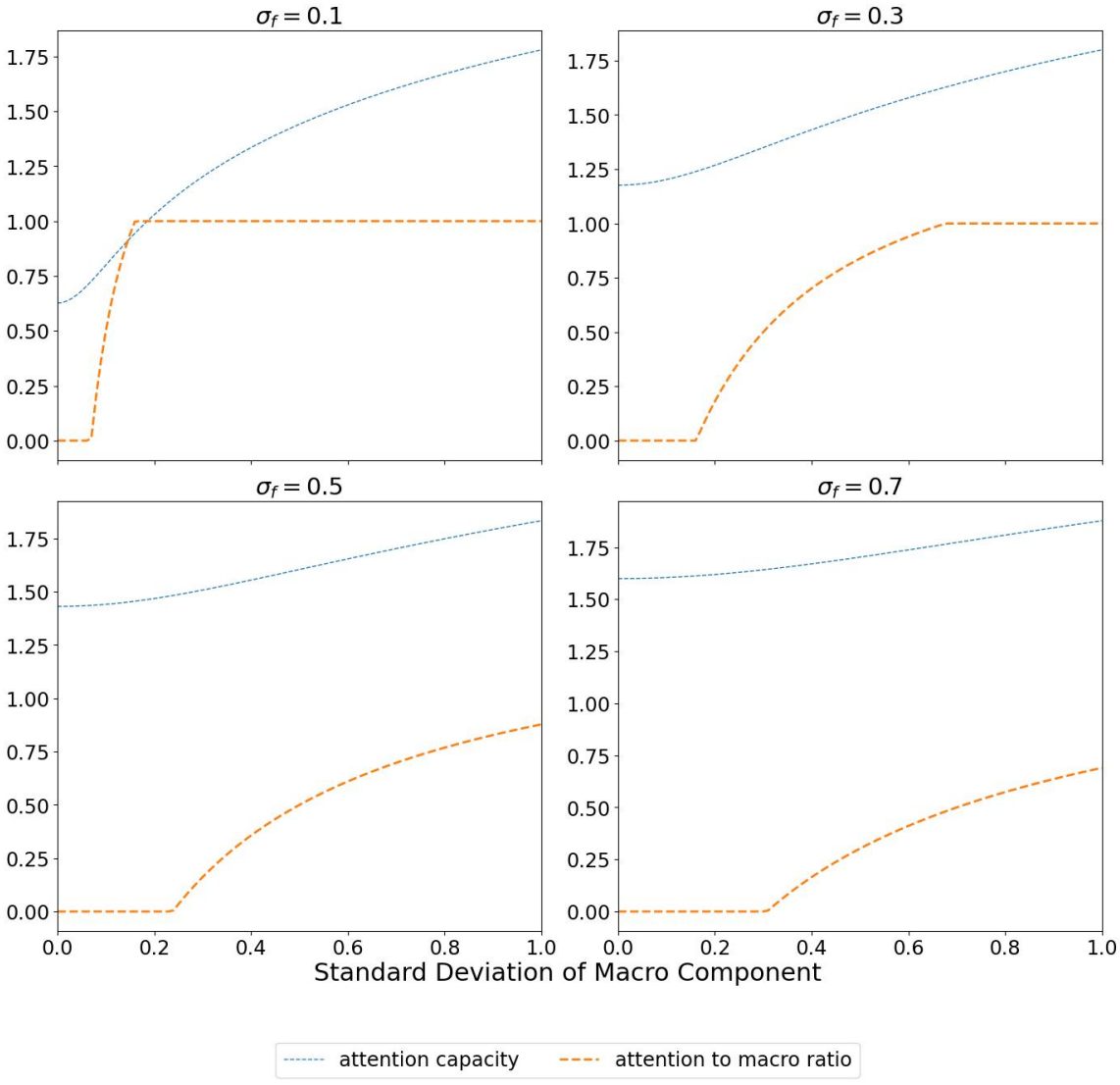
Figure 4: Optimal static capital structure model. Comparative statics with respect to Macro volatility



Note: This figure shows manager's attention capacity κ, attention allocation rate to macroeconomic and firm-specific conditions. The benchmark set of parameters is: $k_0 = 0.8$ and $\theta = 0.5$.

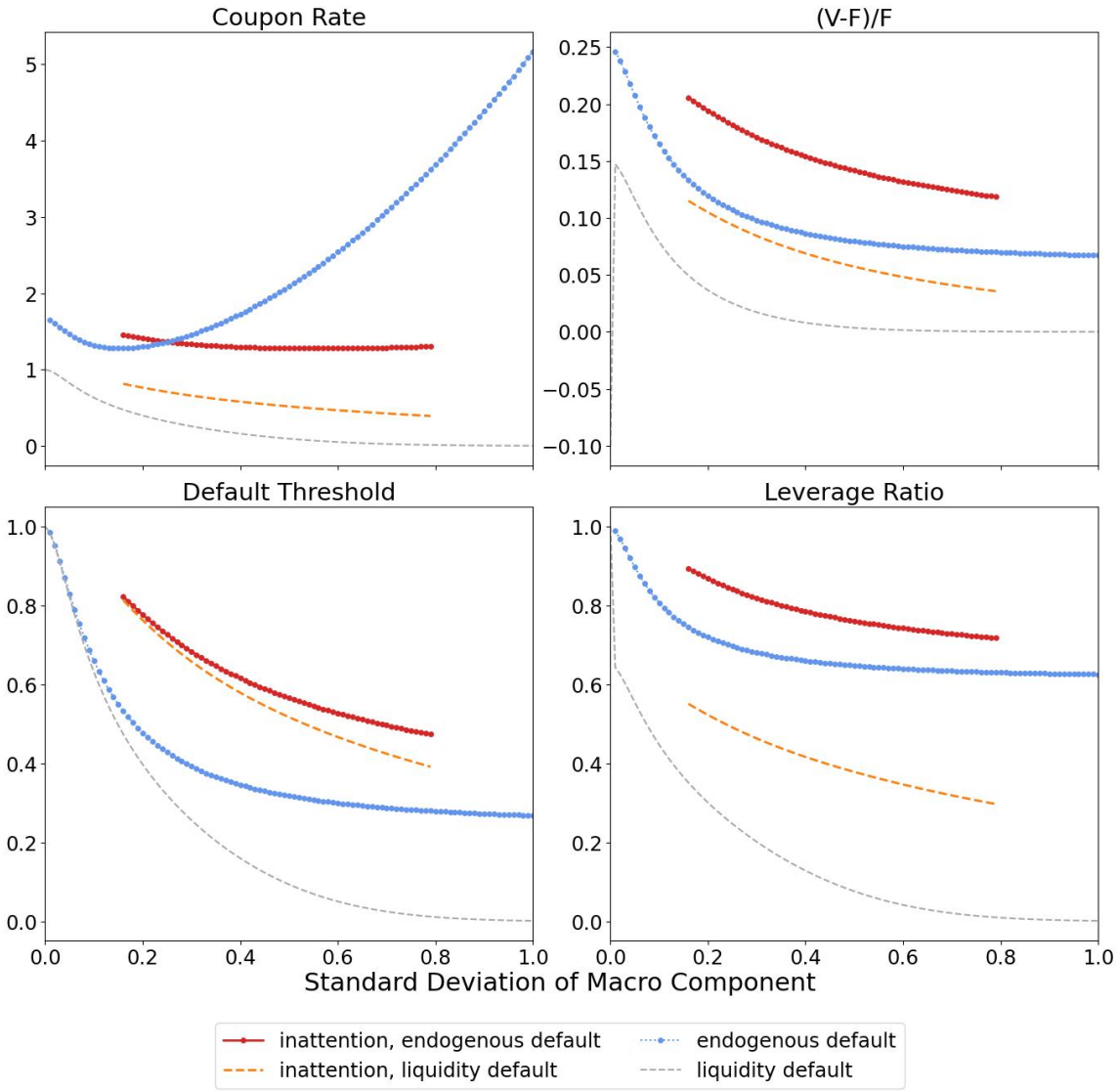
and the grey line present the leverage dynamics under an optimal static capital structure model without an information decision. The red and orange lines show the leverage dynamics with the information decision process. First, with attention consideration, the optimal leverage ratio is higher than the case without attention consideration for all volatility levels of the macroeconomic component.

Figure 5: Optimal Static Capital Structure Model. Comparing the Scale Effect and Substitute Effect.



Note: This figure shows the comparative statics of the attention capacity and attention allocation ratio. The benchmark set of parameters is: $k_0 = 0.8$ and $\theta = 0.5$.

Figure 6: Optimal Static Capital Structure Model. Comparative Statics with Respect to Macro Volatility



Note: This figure shows the comparative statics of the optimal coupon rate, c, the default boundary, X_D, optimal leverage, L, and the difference in values between levered and unlevered firms, $\frac{V-F}{F}$, all with respect to macroeconomic volatility, σ_m, in the optimal static capital structure model. The benchmark set of parameters is: $r = 0.05$, $\mu = 0.02$, $\sigma = 0.25$, $\tau = 0.2$, $X_0 = 1$ and $\alpha = 0.1$, $\sigma_m = 0.2$, $\sigma_f = 0.3$, $\eta_m = 1$, $\eta_f = 1$.

5. Conclusion

Managers are confronted with stimuli from both macroeconomic and firm-specific issues. To introduce managerial efforts of learning about the environment into financing decision making process, I quantify managerial limited attention with attention capacity and attention allocation. Using the new measurements, I demonstrate that firm characteristics and the business cycle can affect the dynamics of managerial attention capacity and allocation.

Using publicly listed firms' quarterly earnings call transcript and NLP, I first quantify managerial attention capacity and attention allocation. I have three findings regarding managerial attention: First, attention capacity and allocation are related to firm characteristics. Large firm size, high profitability, access to the credit market, and growth opportunities will make the managers expand attention capacity and allocate more attention to macroeconomics. Second, both attention capacity and attention allocation are counter-cyclical. They increase during a recession mainly due to increasingly salient macroeconomic information. Third, on average, managers allocate more than half of their attention toward macroeconomics.

I also look into the role of managerial attention in explaining the unprecedented high level of business leverage. Attention capacity is stimulated from the surrounding's uncertainty. Both macroeconomic and firm-specific components play a central role in this process. To simplify the analysis, I assume the firm-specific volatility remain constant while allow the macroeconomic volatility variant. The results show that paying attention to macroeconomics provides both substitution and scale effects. Paying attention to macroeconomics concurs with attention capacity, which significantly increases a firm's leverage ratio by 1.69. Meanwhile, paying more attention to macroeconomics coincides with higher attention allocation toward macroeconomics, supplanting attention paid to firm-specific issues. This, in turn, results in a lower leverage ratio. My finding is robust after controlling for the business cycle, firm characteristics, and consideration of liquidity supply. The finding is also robust with different leverage ratio measurements.

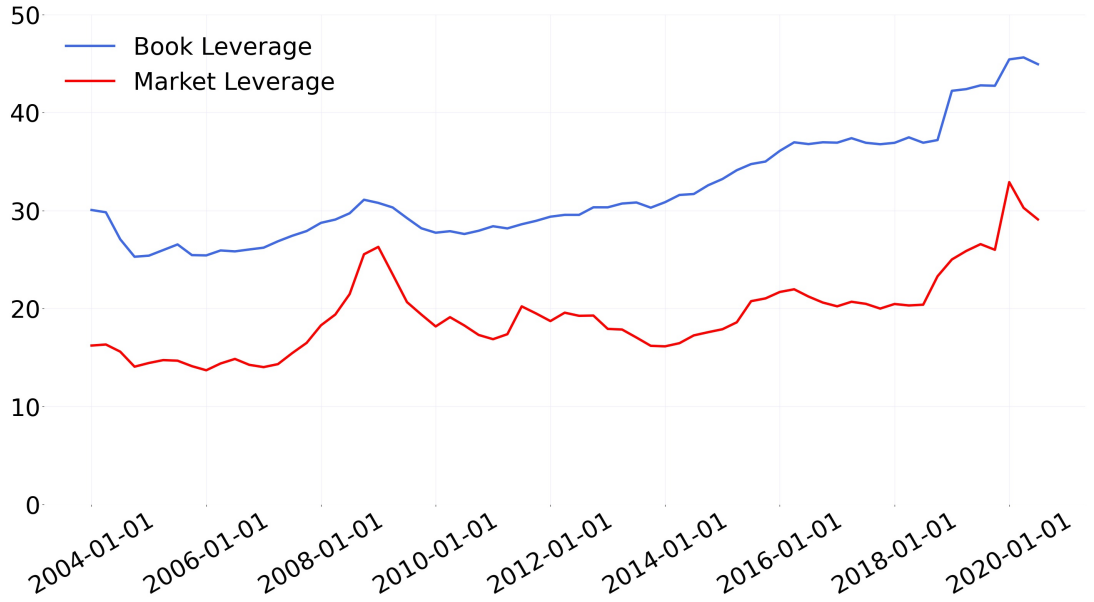
I further investigate the role of managerial attention in amplifying the leverage cycles. By adding intersection terms of managerial attention and business cycles, I find that because attention capacity and attention allocation are counter-cyclical, they amplify the effect of the business cycle on firm-level financial decisions. During a recession, the economic downturn will put pressure on a firm's leverage ratio. My estimation shows that expanded attention capacity doubles the effect from macroeconomics.

My attention measurements and the findings of substitution and scale effect point to some questions for future work. Is managerial attention nature or nurture? Does man-

agerial attention affect financial information released to investors? How does managerial attention impact business cycle dynamics, or long-run innovation, creative destruction, and growth?

Appendix A

Figure A.A.1: Percent Book Leverage and Market Leverage, from 2004Q1 to 2020Q3



Note: This figure shows aggregated percent book leverage and market leverage by taking the mean of each leverage ratio across the 3481 companies in the sample. The data come from Compustat.

Table A.1: Standard Industrial Classification (SIC) Manual

Range of SIC Codes	Division
0100-0999	Agriculture, Forestry and Fishing
1000-1499	Mining
1500-1799	Construction
2000-3999	Manufacturing
4000-4999	Transportation, Communications, Electric, Gas and Sanitary service
5000-5199	Wholesale Trade
5200-5999	Retail Trade
6000-6799	Finance, Insurance and Real Estate
7000-8999	Services
9100-9729	Public Administration
9900-9999	Non-classifiable

Note: This table is reproduced from the United States Department of Labor website. The SIC codes 1800-1999 are not used.

Table A.2: Terms Selected with TF-IDF (Full list)

Category	Terms
Macro	gdp, monetari, deficit, equilibrium, inflat, unemploy, polici, aggreg, multipli, economist, economi,suppli, wage, export, govern, recess, fed, nation, demand, expansionari, labor, phillip, stagflat, fiscal, consumpt, feder, bushel, nomin, surplu, econom, consum, employ, macroeconom, currenc, crisi, tariff, foreign, deflat, crowd, polit, policymak, boom, societi
Firm-specific	bond, firm, dividend, stock, discount, creditor, bankruptci, equiti, return, financ, loan, yield, stockhold, asset, turnov, payment, inventori, matur, valuat, nyse, borrow, debt, liabil, paid, premium, payabl, flow, vote, tax, analysi, owner, pay, depreci, payout, mutual, default, yahoo, taxabl, worth, fix, principl, short, inflow

Note: I use the following three textbooks of corporate finance to select firm-specific terms. *Essentials of Corporate Finance* by Ross, Stephen A., Randolph Westerfield, Bradford D. Jordan, and Ernest N. Biktimirov, *Financial Reporting and Analysis* by Gibson, Charles H, *Principles of Corporate Finance* by Brealey, Richard A., Stewart C. Myers, Franklin Allen, and Pitabas Mohanty. I use the following two textbooks of macroeconomics to select terms about macroeconomic conditions. *Macroeconomics Principles and Policy* by Baumol, J. W., and S. A. Blinder.*Principles of macroeconomics* by Mankiw, N. Gregory, Ronald D. Kneebone, Kenneth James McKenzie, and Nicholas Rowe.

Table A.3: Comparative Statics of the Optimal Static Capital Structure Model

Variable	μ_x	σ_x
Endogenous case		
γ_D	$-$	$-/+$
c	$+.$	$-$
L	$+$	$-$
X_D	$+$	$-$
$\frac{V(X_0)-F(X_0)}{F(X_0)}$	$+$	$-$
Exogenous case		
c	$-/+$	$-$
L	$-$	$-$
X_D	$-/+$	$-$
$\frac{V(X_0)-F(X_0)}{F(X_0)}$	$-$	$-$

Note: μ_x represents the mean of cash flow X and σ_x is the standard error of X. This table is reproduced from Strebulaev and Whited (2011).

Table A.4: Panel Regression, Leverage and Manager's Attention

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Attention Capacity		1.69*** (0.07)		2.01*** (0.07)		1.93*** (0.07)	2.79*** (0.07)	2.09*** (0.07)
Attention Allocation			−5.53*** (0.21)	−6.39*** (0.21)		−6.11*** (0.20)	−4.06*** (0.21)	−4.77*** (0.20)
Firm Size					4.29*** (0.07)	4.34*** (0.07)	5.93*** (0.07)	6.07*** (0.07)
Profitability					−64.1*** (1.13)	−62.5*** (1.12)	−69.5*** (1.15)	−67.9*** (1.14)
Market-to-Book Value					0.01*** (0.00)	0.01*** (0.00)	0.02*** (0.00)	0.02*** (0.00)
Tangibility					23.8*** (0.51)	23.9*** (0.51)	30.0*** (0.51)	28.7*** (0.51)
Real GDP Growth Rate							−0.10*** (0.00)	−0.001 (0.01)
VIX								0.22*** (0.00)
Constant	19.3*** (0.03)	17.4*** (0.09)	22.0*** (0.10)	20.1*** (0.12)	−24.7*** (0.69)	−24.4*** (0.70)	−42.2*** (0.63)	−46.5*** (0.63)
Time Fixed Effect	YES	YES	YES	YES	YES	YES	NO	NO
Sector Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Firm Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Observations	124617	124617	124617	124617	120444	120444	120444	120444
Adjusted R^2	0.75	0.75	0.75	0.75	0.76	0.77	0.75	0.76

Note: Standard errors in parentheses. *** represents $p < 0.01$. I present the coefficient of market-to-book Value as 100 times the original values. The attention allocation is in decimal format instead of percentage for coefficient presentation purpose.

Table A.5: OLS Panel Regression, Leverage and Manager's Attention(drop extreme values)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Attention Capacity		2.02***		2.44***		2.29***	3.39***	2.47***
		(0.09)		(0.09)		(0.09)	(0.09)	(0.09)
Attention Allocation			−5.96***	−7.00***		−6.59***	−4.42***	−5.21***
			(0.24)	(0.24)		(0.23)	(0.24)	(0.23)
Firm Size					4.60***	4.64***	6.12***	6.29***
					(0.09)	(0.09)	(0.08)	(0.08)
Profitability					−82.3***	−80.2***	−87.2***	−84.8***
					(1.39)	(1.38)	(1.42)	(1.39)
Market-to-Book Value					0.013***	0.012***	0.017***	0.018***
					(0.00)	(0.00)	(0.00)	(0.00)
Tangibility					23.4***	23.4***	28.6***	27.4***
					(0.57)	(0.56)	(0.57)	(0.56)
Real GDP Growth Rate							−0.085***	0.012**
							(0.01)	(0.01)
VIX								0.25***
								(0.00)
Constant	22.3***	20.0***	25.2***	22.9***	−25.5***	−25.4***	−42.7***	−47.5***
	(0.03)	(0.11)	(0.12)	(0.15)	(0.84)	(0.84)	(0.77)	(0.76)
Time Fixed Effect	YES	YES	YES	YES	YES	YES	NO	NO
Firm Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Observations	101,346	101,346	101,346	101,346	98,246	98,246	98,246	98,246
Adjusted R^2	0.71	0.71	0.71	0.72	0.73	0.74	0.72	0.73

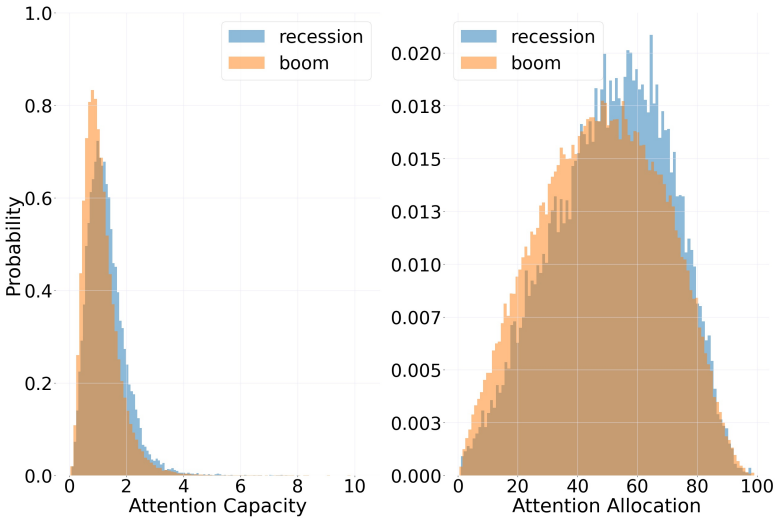
Note: Standard errors in parentheses. *** represents $p < 0.01$. I present the coefficient of market-to-book Value as 100 times the original values. The attention allocation is in decimal format instead of percentage for coefficient presentation purpose. Controlling for sector fixed effect will result in very similar results, see table A. ?

Table A.6: OLS Panel Regression, Leverage and Manager's Attention(use residuals)

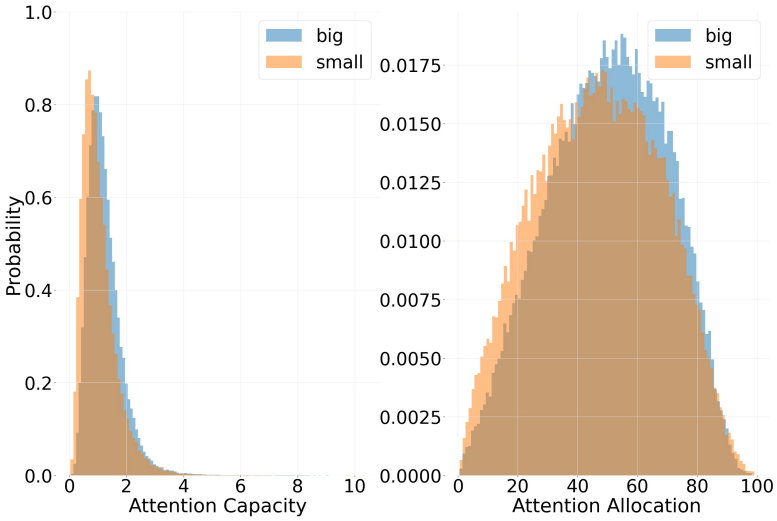
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Residual of Attention Capacity		1.69***		2.01***		1.93***	2.08***	2.09***
		(0.07)		(0.07)		(0.07)	(0.07)	(0.07)
Residual of Attention Allocation			−5.53***	−6.39***		−6.11***	−4.68***	−4.77***
			(0.21)	(0.21)		(0.20)	(0.21)	(0.20)
Firm Size					4.29***	4.34***	5.92***	6.07***
					(0.07)	(0.07)	(0.07)	(0.07)
Profitability					−64.1***	−62.5***	−69.9***	−67.9***
					(1.13)	(1.12)	(1.15)	(1.14)
Market-to-Book Value					0.013***	0.013***	0.018***	0.020***
					(0.00)	(0.00)	(0.00)	(0.00)
Tangibility					23.8***	23.9***	30.2***	28.7***
					(0.51)	(0.51)	(0.52)	(0.51)
Real GDP Growth Rate							−0.11***	−0.0023
							(0.00)	(0.01)
VIX								0.24***
								(0.00)
Constant	19.3***	19.3***	19.3***	19.3***	−24.7***	−25.2***	−41.0***	−46.7***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.69)	(0.69)	(0.63)	(0.63)
Time Fixed Effect	YES	YES	YES	YES	YES	YES	NO	NO
Firm Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Observations	124,617	124,617	124,617	124,617	120,444	120,444	120,444	120,444
Adjusted R^2	0.75	0.75	0.75	0.75	0.76	0.77	0.75	0.76

Note: Standard errors in parentheses. *** represents $p < 0.01$. I present the coefficient of market-to-book Value as 100 times the original values. The attention allocation is in decimal format instead of percentage for coefficient presentation purpose. Controlling for sector fixed effect will result in very similar results, see table A. ?. The results shown in this table use the residual of regression of attention capacity on GDP growth rate and VIX.

Figure A.A.2: Manager Attention, Business Cycle and Size



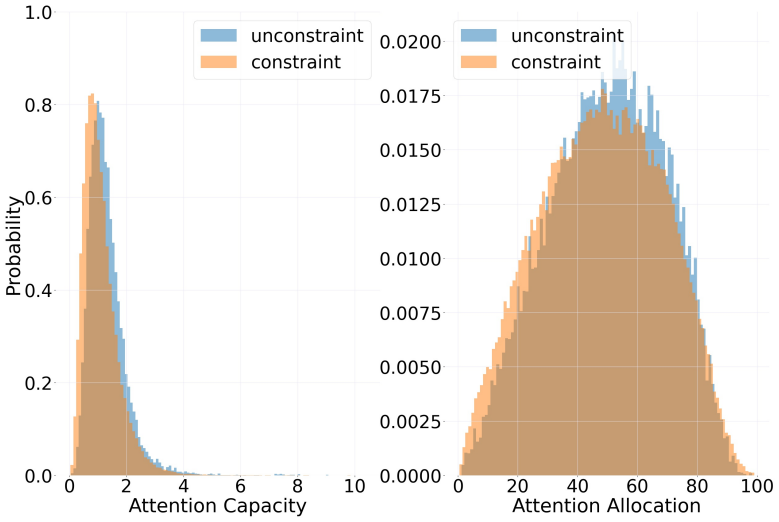
(a) Manager's Attention is State Dependent



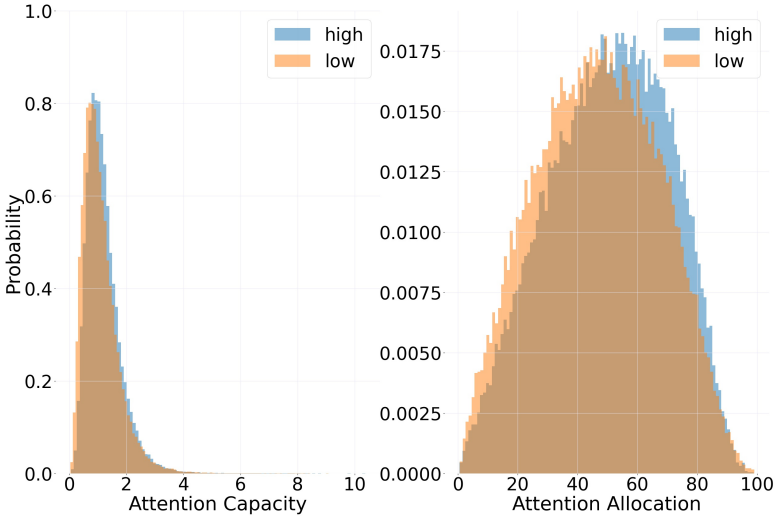
(b) Manager's Attention is Size Dependent

Note: Subfigure (a) shows that managerial attention capacity and attention allocation toward macroeconomics are counter-cyclical. In recession, managers have higher attention capacity and attention allocation. Subfigure (b) shows that managerial attention capacity and attention allocation toward macroeconomics are higher for larger firms.

Figure A.A.3: Manager Attention, Liquidity and Profitability



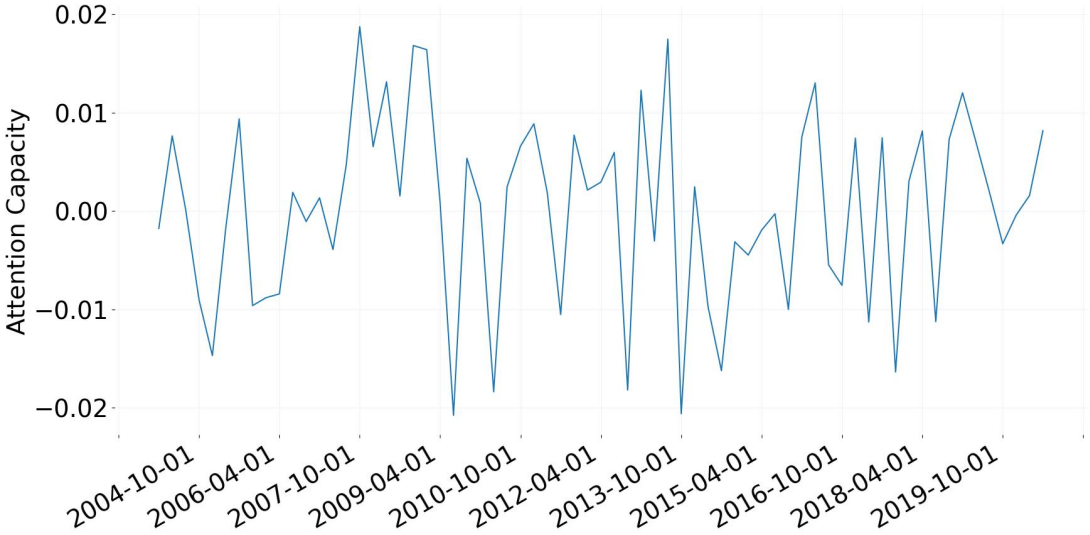
(a) Manager's Attention is Liquidity Dependent



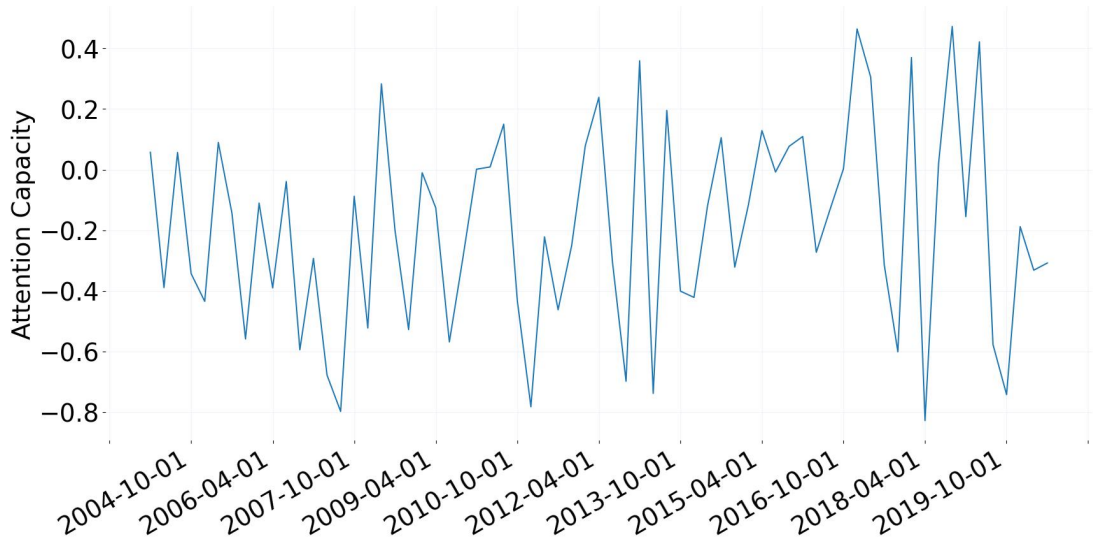
(b) Manager's Attention is Profitability Dependent

Note: Subfigure (a) shows that managerial attention capacity and attention allocation toward macroeconomics are higher for financially unconstrained firms. Here I define financially unconstrained firms as those that have access to public debt market. Subfigure (b) shows that managerial attention capacity and attention allocation toward macroeconomics are higher for firms with higher profitability.

Figure A.A.4: The Manager Attention is Distinct from Business Cycles



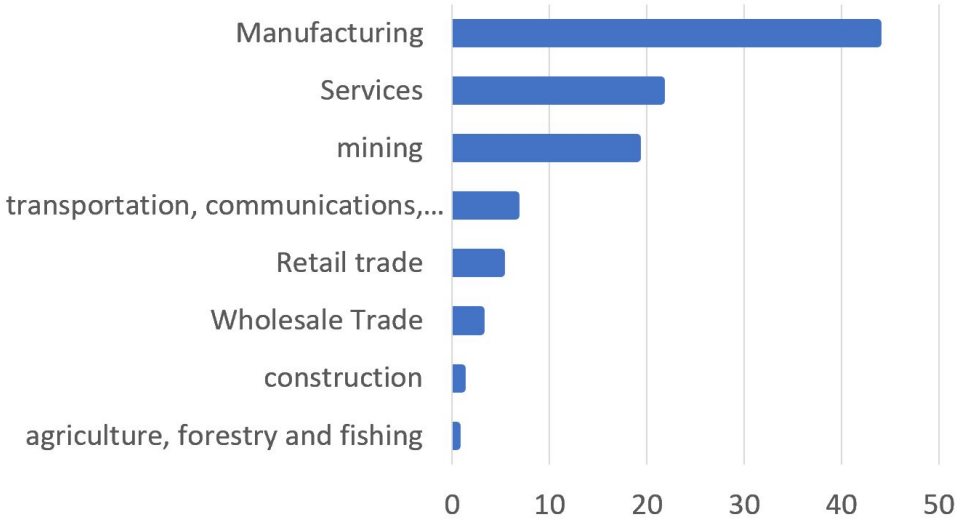
(a) The Residual of Attention Capacity on Business Cycles



(b) The Residual of Attention Allocation on Business Cycles

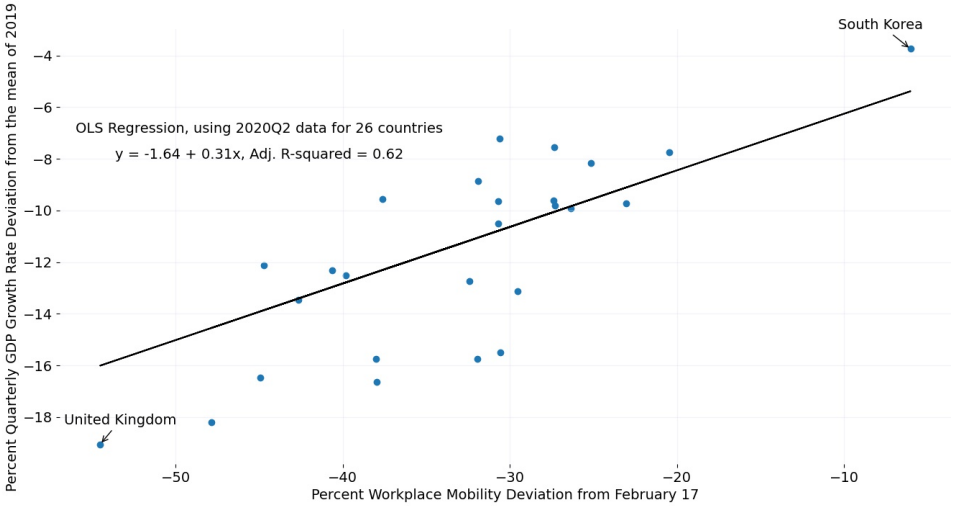
Note: This figure presents the residuals of manager attention capacity and attention allocation regress on real GDP growth rate and VIX.

Figure A.A.5: Sample Industry Distribution (percent)



Note: This figure shows the industry distribution of the full sample.

Figure A.A.6: Real GDP Growth Rate Deviations and Workplace Mobility Deviations in A Cross Section of Countries in the Second Quarter of 2020



Notes: This chart considers 26 countries for which we have data on both Google's Workplace Mobility Deviation and the quarterly real GDP growth rate in the second quarter of 2020. We exclude Ireland because its GDP data are heavily affected by net factor income from abroad associated with tax avoidance behavior by multinational businesses. On the vertical scale, we plot the country's real GDP growth rate in the second quarter of 2020 minus its average quarterly growth rate in 2019, which we interpret as a reasonable pre-pandemic baseline for the country's real GDP growth rate. On the vertical scale, we plot the country's average daily value of its Workplace Mobility Deviation during the second quarter of 2020.

Appendix B

Derive the sum of two Brownian Motions. Define $G_t = \sigma_a W_t^a + \sigma_m W_t^m$.

$$\begin{aligned} Var(G_t - G_s) &= Var((\sigma_a W_t^a + \sigma_m W_t^m) - (\sigma_a W_s^a + \sigma_m W_s^m)) \\ &= Var((\sigma_a W_t^a - \sigma_a W_s^a) + (\sigma_m W_t^m - \sigma_m W_s^m)) \\ &= Var(\sigma_a(W_t^a - W_s^a) + \sigma_m(W_t^m - W_s^m)) \\ &= \sigma_a^2 Var(W_t^a - W_s^a) + \sigma_m^2 Var(W_t^m - W_s^m) \\ &+ 2Cov(\sigma_a(W_t^a - W_s^a), \sigma_m(W_t^m - W_s^m)) \\ &= \sigma_a^2 Var(W_t^a - W_s^a) + \sigma_m^2 Var(W_t^m - W_s^m) + 0 \\ &= (t-s)(\sigma_a^2 + \sigma_m^2) \end{aligned} \tag{61}$$

Thus, $\frac{G_t}{\sqrt{\sigma_a^2+\sigma_m^2}}$ is also a Brownian Motion, which I denote as W_t^x. I also assign $\sigma_x^2 = \sqrt{\sigma_a^2 + \sigma_m^2}$.

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