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Essays on Agency Problems

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Essays on Agency Problems

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DISSERTATION

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

DOCTOR OF PHILOSOPHY

THE UNIVERSITY OF TEXAS AT AUSTIN

May 2020

Dedicated to my wife Soojung and my son Jian.

Acknowledgments

I am grateful for the comments received from Daniel Ackerberg, Eugenio Miravete, Richard Lowery, Robert Town, Gregor Matvos, Jorge Balat, Ari Kang, Sukjin Han, Sungwon Lee, Jaemin So, James Brand.

Essays on Agency Problems

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The University of Texas at Austin, 2020

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This dissertation addresses many important economic questions surrounding agency problems and vertical incentives. The first chapter documents the institutional background and pricing of U.S. reverse convertible bonds. The primary reason why I look into the reverse convertible bonds market is that it has interesting variation, enabling me to answer research questions in the second chapter and the third chapter. The second chapter shows some suggestive evidence of agency problems and vertical incentives in the reverse convertible bonds market mainly using a reduced-form analysis. Finally, the third chapter estimates the degree of agency problems and the degree of vertical incentives using a structural model. I conclude by analyzing various counterfactual scenarios.

The first chapter introduces a financial product called a reverse convertible bond. It documents the product, market structure, and distribution process of the bond. Using a data set on reverse convertible bonds, I calculate

the fair value of each bond by which I derive an issuer markup, i.e. how much an issuer earns by issuing each bond. This variable plays a critical role in investigating agency problems and vertical incentive issues in the second and third chapters. I also introduce my second data set on broker firms in this chapter.

The second chapter documents some suggestive evidence of agency problems and vertical incentives in the reverse convertible bonds market. Combining two data sets described in the first chapter, I show descriptive evidence of agency problems and vertical incentives which are against the relevant regulations in the market. Specifically, broker behavior indicates agency problems while the relevant regulations such as suitability standard or fiduciary duty prevent them from doing so. In addition, I show that brokers are sensitive to their vertically integrated upstream firm's profit while arms-length transaction laws prohibit them from doing so.

The final chapter estimates the degree of agency problems as well as the degree of vertical incentives in the reverse convertible bonds market. Although I show suggestive evidence of agency problems and vertical incentives in the second chapter, it is not straight forward to estimate their severity using a reduced-form analysis. Thus, I introduce a structural model that allows us to estimate the degree of agency problems and the degree of vertical incentives. The estimation results suggest that there are severe levels of both agency problems and vertical incentives in the market. Lastly, the counterfactual analysis shows that there is a substantial consumer surplus loss arising from agency problems. I also document a consumer welfare loss coming from vertical incentives but the magnitude is smaller than the consumer welfare loss from agency problems.

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Chapter 1

Reverse Convertible Bonds and Their Pricing

1.1 Introduction

1.1.1 Research Question

This chapter studies reverse convertible bonds. The reason why I study the reverse convertible bond market is that this market is a perfect place to study agency problems and vertical incentives. I document the institutional backgrounds of the reverse convertible bonds market and their pricing in this chapter. Then, in later chapters, I will look into economic questions surrounding agency problems and vertical incentives using variation from this market after I explain the product and the market structure in this chapter.

Many researchers have studied agency problems in the financial market. Often times, investors rely on financial intermediaries when they choose a product. However, there can be a conflict of interest meaning brokers' own incentives can differ from their investors' incentives. What makes things more complicated is that usually there are informational asymmetries. Brokers know better than investors about the financial product and the market. This is the very reason why investors rely on brokers in the first place. But, at the same time, as brokers know better than investors, maybe it is possible for brokers to navigate their investors into certain products in order to maximize their own incentives rather than maximizing investors' profits. Another consideration is vertical incentives. If brokers are vertically integrated with their upstream firms, they might be affected by their vertical relationships.

A reverse convertible bond market is a very interesting market to answer these questions. I'll explain why this is a perfect place to look into these questions. First, a reverse convertible bond is a retail product targeting affluent households rather than sophisticated institutional investors. To give a better sense on who are buying these bonds, the Royal Bank of Canada's guidelines restricted reverse convertible bond sales to investors with the following profile: 1) $100,000 or more in annual income, 2) at least $100,000 in liquid assets, 3) a net worth of $250,000 or more, 4) at least two years of prior investment experience. [1] They are rich households but typically they are not as sophisticated as institutional investors are. Second, a reverse convertible bond is a complex financial product. Unlike other bonds, it is linked to an underlying stock price, meaning a bond investor receives a payoff that is a function of the price of a specific predetermined stock. For instance, many reverse convertible bonds are linked to an Apple stock price. The returns from these bonds are high when the Apple stock price stays high and the returns are low when the Apple stock price goes below some trigger level. This is one of the reasons why the Financial Industry Regulatory Authority issued a warning about reverse convertible bonds. Here is what the Financial Indus-

[1] Source: StarTribune website. Available at `https://www.startribune.com/buy-a-reverse-convertible-sure-what-is-it/301260161/`

try Regulatory Authority says: "The bottom line is that reverse convertibles come not only with the risks that fixed income products ordinarily carry - such as the risk of issuer default and inflation risk - but also with any additional risks of underlying asset." [2] As the payoff is linked to an underlying asset, it involves many scenarios making the payoff complicated. Note that many financial experts say retail investors should be more cautious when investing in complex products. For instance, this is a direct quote from Larry Swedroe who is a director of research for the Buckingham Asset Management Alliance. "Generally speaking, the more complex an investment product, the faster you should run from it. In nearly all cases, the complexity is designed to favor the issuer." [3] Note that this article introduces reverse convertible bonds as one of the bad investments. Due to this complex feature, it is essentially a high-risk, high-return product. A bond investor receives a high return as long as the underlying stock price performs well. On the other hand, when the underlying stock price decreases, there is a significant downside risk. Also, it is not principal protected, so an investor may lose a significant amount of the principal depending on the performance of a single stock price, which can be very volatile. Third, it is a high-fee product. Many retail investors are purchasing reverse convertible bonds by paying high fees. In this chapter, I show that the seller's margins are almost 7% on average using my data set. Fourth,

[2] Source: the Financial Industry Regulatory Authority website. Available at `https://www.finra.org/investors/alerts/reverse-convertibles-complex-investment-vehicles`

[3] Source: CBS NEWS website. Available at `https://www.cbsnews.com/news/bad-investments-reverse-convertibles/`

there are almost no secondary markets for reverse convertible bonds. This is a direct quote from MarketWatch columnist Chuck Jaffe's article in the Seattle Times: "That's distinctly true for reverse convertibles, where the lack of a secondary market makes them virtually impossible to unload at a fair price before maturity." [4] Also note that the article is titled "Stupid investment of the week: Reverse convertible securities". The StockMarketLoss also points out the illiquidity of reverse convertible bonds: "Because secondary trading for the reverse convertible would be limited or non-existent, the investment would be highly illiquid." [5]

Another notable feature of the reverse convertible bond market is that there have been many lawsuits involving this market. Although some retail investors have expressed that they were looking for a stable and less risky income, many retail investors purchased reverse convertible bonds following their broker's recommendations. At maturity, they found that they lost a significant part of their principal as the underlying stock price fell. They were not fully informed about the risk when they made an investment, causing them to initiate lawsuits. Eventually, many broker firms who were sued by their retail investors had to settle their charges by paying multi-million dollar fines. In 2016, to name a few, UBS Financial Services paid $15 million to settle charges in connection with the sale of reverse convertible bonds. [6] In

[4]Source: The Seattle Times website. Available at `https://www.seattletimes.com/business/stupid-investment-of-the-week-reverse-convertible-securities/`

[5]Source: StockMarketLoss website. Available at `https://www.stockmarketloss.com/structured-products/apple-linked-reverse-convertibles/`

[6]Source: the U.S. Securities and Exchange Commission website. Available at `https:`

2015, RBC Capital Markets also paid a $1 million fine for supervisory failures resulting in sales of unsuitable reverse convertible bonds. [7] In 2011, Wells Fargo Investments was fined $2 million for unsuitable reverse convertible bond sales to senior citizens who were over 80 years old. [8] In 2010, the Financial Industry Regulatory Authority fined H&R Block Financial Advisors $200,000 for failing to establish adequate procedures for supervising sales of reverse convertible bonds to its retired couple. [9] Although there have been many lawsuits concering reverse convertible bonds, there are many retail investors who engage in this market. In terms of market size, this bond market exceeded 10 billion dollars in the U.S. and over 50 billion dollars globally in 2008. [10]

Given the large number of lawsuits in this market, one may wonder why retail investors are buying reverse convertible bonds. There could be many reasons. One reason could be because of its complex structure. As mentioned, reverse convertible bonds have a complex payoff which makes it difficult for retail investors to evaluate risks properly. For instance, in a later section, I calculate the risks associated with reverse convertible bonds using equity option pricing models from Reiner and Rubinstein (1991a, 1991b) which

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//www.sec.gov/news/pressrelease/2016-197.html

[7]Source: Financial Industry Regulatory Authority website. Available at https://www.finra.org/media-center/news-releases/2015/finra-orders-rbc-pay-fine-and-restitution-totaling-more-14-million

[8]Source: Financial Industry Regulatory Authority website. Available at https://www.finra.org/media-center/news-releases/2011/finra-fines-wells-fargo-2-million-unsuitable-sales-reverse-convertibles

[9]The MarketWatch website. Available at https://www.marketwatch.com/story/regulator-fines-hr-block-200k-for-poor-controls-2010-02-16

[10]Laise (2008), Alloway (2015)

are modifications of the Black and Scholes option pricing model. It is hard to expect most retail investors to be in a position to use these pricing models when they make an investment decision. There is a quote from StockMarketLoss: “The broker-dealer was charging you an up-front embedded fee (2% or much more) for assembling and packaging the reverse convertible's individual components, but if you wanted to know the true size of this embedded fee, you'd find it virtually impossible to calculate.” [11] Next, maybe they are misled by high coupons, especially in a low-yield environment. Many reverse convertible bonds attract retail investors by paying high coupons. In my data set, the average coupon is higher than 10%. However, this does not guarantee retail investors a 10% return. When an underlying stock price falls, their return could be -30% instead of 10%. Coupled with the fact that reverse convertibles have a complex structure, it could give retail investors the wrong impression that these bonds pay higher coupons without significant risks. A relevant article titled “Risky Strategy Lures Investors Seeking Yield - Popular 'Reverse Convertibles' Offer Lucrative Payouts But Could Cause Steep Losses” was published in the Wall Street Journal in 2008. It describes as follows. “Wall Street is luring income-hungry investors with complex securities that come with big risks as well as extravagant yields.” [12] Larry Swedroe of Buckingham Asset Management also describes this as “People get mesmerized

[11] Source: StockMarketLoss website. Available at `https://www.stockmarketloss.com/structured-products/apple-linked-reverse-convertibles/`

[12] Source: The Wall Street Journal website. Available at `https://www.wsj.com/articles/SB120648718371963833`

by the high yield. That is what attracts them to the shiny red apple that the witch is holding. " [13] It is also worth noting that the Financial Industry Regulatory Authority issued an investor alert in 2011 saying "Be wary of any advertisements or sales literature suggesting that reverse convertibles are safe and suitable for investors seeking high yields. These sales pitches may play up the high yield on the note and play down the risk of the derivative component." [14] Lastly, we need to consider brokers' recommendations as well. As we have seen in the case of lawsuits, brokers recommended these risky products to elderly customers or a retired couple who explicitly preferred safe and stable incomes to high-risk high-return investments. Given that these products offer high fees to sellers, maybe brokers are over-recommending financial products to their retail investors who are not suitable for this type of investment. See a direct quote from a MarketWatch columnist: "What's particularly egregious about reverse convertibles is that they are being sold as a reasonably safe alternative investment when, in fact, virtually all of the downside risk falls on the buyer." [15]

Retail investors are considered to be more vulnerable than institutional investors are so there are regulations in place to protect them. In the U.S. reverse convertible bond market, suitability standards and fiduciary duties are

[13]Source: The Seattle Times website. Available at `https://www.seattletimes.com/business/stupid-investment-of-the-week-reverse-convertible-securities/`

[14]Source: Financial Industry Regulatory Authority website. Available at `https://www.finra.org/investors/alerts/reverse-convertibles-complex-investment-vehicles`

[15]Source: The Seattle Times website. Available at `https://www.seattletimes.com/business/stupid-investment-of-the-week-reverse-convertible-securities/`

required for financial advisers to sell reverse convertible bonds. First, brokers are regulated by the Financial Industry Regulatory Authority and are held to a suitability standard, which states, "Financial Industry Regulatory Authority Rule 2111 requires that a member or an associated person must have a reasonable basis to believe that a recommended transaction or investment strategy involving a security or securities is suitable for the customer, based on the information obtained through the reasonable diligence of the member or associated person to ascertain the customer's investment profile." [16] Second, investment advisers are regulated by the U.S. Securities and Exchange Commission and are held to the following fiduciary standard: "As fiduciaries, investment advisers are required to act in the best interest of clients and to not place their own interests ahead of their clients." [17] In this regard, I'm interested in whether these regulations are working or not. Are financial advisers acting in the best interest of their clients or not? In other words, I'm interested in whether there are agency problems or not. Furthermore, I'm also interested in how severe agency problems are if there exist agency problems.

In addition, I also consider vertical incentives. In the reverse convertible bond market, brokers not only sell their vertically integrated firm's products but they also sell their competitor's products. For instance, JP Morgan brokers not only sell JP Morgan bonds but they also sell UBS bonds. Does a JP

[16]Source: the Financial Industry Regulatory Authority website. Available at `https://www.finra.org/rules-guidance/rulebooks/finra-rules/2111`

[17]Source: Investment Adviser Association website. Available at `https://www.investmentadviser.org/home/side-content/sec-standard`

Morgan broker sell JP Morgan bonds in the same way he sells UBS bonds? Or does he favor selling JP Morgan bonds compared to selling UBS bonds? The arms-length transaction regulation which governs a vertical incentive structure in this market requires JP Morgan brokers not to favor JP Morgan bonds over UBS bonds. I'm also interested in whether the arms-length transaction regulation is working or not. If it is not working, how severe are vertical incentives in the market?

In order to answer these questions, I study the U.S. reverse convertible bond market as its data show interesting variations. Before jumping into my economic research questions, in this chapter, I document the reverse convertible bonds and their pricing. Once I explain the institutional background, I will explain what variations I use to answer the research questions in later chapters.

1.1.2 Contributions to the Literature

A major contribution of this chapter is that it combines agency problems and vertical incentives. Egan (2019) also investigates agency problems in the reverse convertible bond market. However, vertical incentives are not considered in his paper. Due to data limitations, he assumes that there is a representative broker. For instance, he assumes that a JP Morgan broker behaves in the same way a UBS broker does. However, using data set on broker firms, I test this assumption and show evidence that a JP Morgan broker behaves differently than a UBS broker does. In addition to combining agency problems and vertical incentives, it is also related to structured products (Henderson and Pearson 2011; Szymanowska, Horst and Veld 2009; Bergstresser 2008; Benet, Giannetti, and Pissaris 2006; Stoimenov and Wilkens 2005) as reverse convertible bonds belong to structured products. While the literature focuses on how to calculate bond fair values or on documenting high fees in the structured product markets, I focus on other economics questions such as agency problems and vertical incentives.

The remainder of the chapter is organized as follows. Section 2 explains the institutional backgrounds such as the product, market structure, and distribution process. Section 3 describes two data sets. In Section 4, I explain how I calculate the fair value of each bond. Section 5 concludes the chapter.

1.2 U.S. Reverse Convertible Bonds Market

In this section, I first explain the product, reverse convertible bonds. Next, I explain the market structure where three types of players are engaged. Lastly, I provide an explanation of how these bonds are distributed.

1.2.1 Reverse Convertible Bond

A reverse convertible bond generally pays fixed interest rates during the life of the bond, but it is tied to a performance of a particular single stock. If the value of that stock falls by a large amount beyond a predetermined trigger level, the bond principal is reduced to that low equity value. In this case, the investor incurs a significant loss. In order to better understand a reverse convertible bond, first consider the example of a one-year reverse convertible bond issued by JP Morgan on 26 August 2008 shown in Table 1.1. The maturity date is 28 August 2009 so the maturity is one year. A monthly coupon is 10% and the underlying asset is an Apple stock price. The initial share price is $173 and trigger share price $104 which corresponds to 60% of the initial share price. Note that this is not a hypothetical bond. This is a real example from my data set. If an investor believes the Apple stock price will not fall by 40% but also does not believe it will increase significantly, then the investor should consider buying this Apple-linked reverse convertible bond instead of buying the Apple stock. When the bond was issued, the stock price of Apple was $173, which is called the initial share price. Once the investor purchases, she observes the share price of the underlying asset or the Apple stock price on a daily basis and one of two scenarios can occur. In the first scenario, the Apple stock price never closes below the trigger share price during the life of the bond. As one can see from Table 1.1, the predetermined trigger share price is $104, which is 60% of the initial share price. In this case, the investor gets the full principal at maturity plus a 10% coupon received before maturity, so the total return will be 10%. [18] The second scenario is when the share price of the underlying asset ever closes below the trigger share price. As long as it closes below the trigger share price at least once, the bond investor's principal is converted into equity and she receives a payoff, as shown

[18] Throughout the chapters, discounting is ignored since all the bonds analyzed are short-term bonds.

in Figure 1.1. On the x-axis, it shows the Apple stock price at maturity and on the y-axis, it shows how much a return the investor gets when converted in terms of percentage. When the Apple stock price hits the trigger share price, the investor receives one share of the Apple stock for every $173 (initial share price) invested, which is now only worth $104. Thus, the investor incurs a loss of 40% on the principal and receives a 10% coupon, so the total return is -30%. Depending on the performance of the stock, the investor may recover some of the loss or suffer even more loss, as shown in Figure 1.1. For example, if the Apple stock price recovers back to the initial share price $173, then the return for an investor would be 10%. On the other hand, if the Apple stock price goes down below the trigger share price, then an investment loss would be larger than 30%. Overall, compared to buying the Apple stock, the reverse convertible bond provides downside protection up to 40%, but the investor is giving up upside potential when the Apple stock price increases by more than 10%.

As seen from this example, reverse convertible bonds are interest-paying bonds for which repayment of the principal is tied to the performance of an underlying asset. You can also find the formal definition of structured notes which is a broader concept encompassing reverse convertible bonds from the U.S. Securities and Exchange Commission: "Structured notes are securities issued by financial institutions whose returns are based on, among other things, equity indexes, a single equity security, a basket of equity securities, interest rates, commodities, and/or foreign currencies." [19] In this example, the Apple stock served as an underlying asset, but other stocks could also serve as an underlying asset. The ten most popular underlying assets are presented in Table 1.2. An Apple stock is the most frequent underlying asset followed by a Bank of America stock and a Caterpillar stock. Note that when a financial institution serves as an underlying asset, it does not necessarily mean the financial institution is an issuer of a bond. For instance, JP Morgan ranks 5th in the ten most popular underlying assets list. This does not necessarily mean that JP Morgan issued a bond that is linked to the performance of a JP Morgan stock price. It could be that UBS issued a reverse convertible bond that is linked to the performance of a JP Morgan stock price. The same argument applies to Bank of America and Citigroup. Using this information, I add equity fixed effects in later chapters for the ten most popular underlying assets and the rest. For instance, investors who invest in General Electric Company linked reverse convertible bonds can be fundamentally different from investors who invest in Freeport-Mcmoran Inc. linked reverse convertible bonds. In that case, equity fixed effects will control for these differences.

Lastly, there are two types of reverse convertible bonds: single observation and continuous observation. The example with the Apple stock price above shows a case of a continuous observation type. While we observe the stock price on a daily basis for continuous observation bonds, we observe the

[19] Source: The U.S. Securities and Exchange Commission website. Available at `https://www.sec.gov/oiea/investor-alerts-bulletins/ib_structurednotes.html`

stock price only at maturity for single observation bonds. This is why we call them single observation and continuous observation. Everything else equal, a continuous observation bonds are riskier for an investor than is a single observation bond. Imagine a stock price hits a trigger share price during the life of a bond and then it recovers to some extent but it is still lower than an initial share price at maturity. In this scenario, an investor for a continuous observation bond loses some of her principal as the stock price closes below an initial share price at the maturity date. On the other hand, an investor for a single observation type does not lose any part of her principal as a stock price at maturity date is higher than a trigger share price. Other than this case, an investor receives the same payoff from both types of bonds. In my data set, continuous observation bonds are more commonly seen than single observation bonds.

1.2.2 Market Structure

In terms of market structure, as shown in Figure 1.2, there are three types of players in the reverse convertible bonds market: upstream issuers, downstream broker firms, and retail investors. The upstream issuers create and issue reverse convertible bonds to earn issuer markups (4.61% on average in my data set). Barclays, UBS, and JP Morgan operate as issuers, and they are responsible for more than 80% of bond issuance. They sell bonds with the aid of downstream broker firms, who observe all the reverse convertible bonds and market bonds directly to their retail investors. For instance, a JP Morgan broker firm not only sells JP Morgan-issued bonds but also UBS-issued bonds. They earn broker fees (2.24% on average in my data set) when they sell the bonds. One thing to note is that each bond has its own broker fee which applies to all brokers in the market. For instance, Bond 1 can have a broker fee of 2%, and Bond 2 can have a broker fee of 5%. However, conditional on Bond 1, a 2% broker fee applies to every broker in the market. For the same bond, a JP Morgan issuer is not allowed to pay 5% to a JP Morgan broker firm while paying only 2% to a UBS broker firm. The group of broker firms that are not affiliated with any issuer is called third-party brokers. For example, Edward Jones operates in the downstream broker firms market but does not engage in the upstream issuers market. I denote them by "Others" in Figure 1.2. Consumers are retail investors who receive coupons (10.51% on average in my data set). Typically, they are affluent households. The Royal Bank of Canada's guidelines restricted reverse convertible bond sales to investors with the following profile: 1) $100,000 or more in annual income, 2) at least $100,000 in liquid assets, 3) a net worth of $250,000 or more, 4) at least two years of prior investment experience. [20] They buy and hold bonds.

As seen in Figure 1.2, Barclays, UBS, and JP Morgan all operate in the upstream and downstream markets, so one might expect vertical relationships between two units of the same firm. However, the arms-length transaction rule governs the relationships between upstream firms and downstream firms, as

[20] Source: StarTribune website. Available at `https://www.startribune.com/buy-a-reverse-convertible-sure-what-is-it/301260161/`

follows: "Financial Industry Regulatory Authority Rule 2232 (f) (3): 'arms-length transaction' shall mean a transaction that was conducted through a competitive process in which non-affiliate firms could also participate, and where the affiliate relationship did not influence the price paid or proceeds received by the member." [21] In other words, the arms-length transaction regulation requires that upstream issuers and downstream broker firms must operate independently even if they are vertically integrated. For instance, a JP Morgan broker firm is required to do business with a JP Morgan issuer in the same way they do business with a UBS issuer.

1.2.3 Distribution Process

The distribution process of bonds is described in Figure 1.3 using the same example I used when explaining the product. Coupon (10.00%), broker fee (2.89%), underlying asset (Apple) and trigger share price (60%) are set in advance by an issuer (JP Morgan issuer). Note that each bond may have a different broker fee, but one broker fee applies to all the broker firms that sell it. For instance, a JP Morgan issuer is not allowed to pay a high broker fee to a JP Morgan broker firm while paying a lower broker fee to a UBS broker firm for the same bond. A marketing period is usually one month, and this bond was issued in August 2008, which indicates that the marketing started in July 2008. Over the course of the month, brokers at each broker firm market

[21] Source: Financial Industry Regulatory Authority website. Financial Industry Regulatory Authority is a non-governmental organization that regulates member brokerage firms. Available at `https://www.finra.org/rules-guidance/rulebooks/finra-rules/2232`

available reverse convertible bonds to their retail investors. Note that not only a JP Morgan broker firm markets this bond but other broker firms such as a Barclays broker firm or a UBS broker firm also market this bond. After one month, all of the orders are summed up so that the size of a reverse convertible bond exactly matches consumer demand. In this case, total consumer demand is $1,186,000. This means the supply curve is very elastic. For regulatory reasons, issuers sell reverse convertible bonds only through brokers rather than selling them directly to consumers. [22]

1.3 Data

This section describes two data sets. The first data set covers information on reverse convertible bonds and the second data set covers information on broker firms in the market.

1.3.1 Data on Reverse Convertible Bonds

The first data set covers every one-year maturity reverse convertible bond issued in 2008-2012 in the U.S. registered with the U.S. Securities and Exchange Commission (3,066 observations). [23] Issuance data are from the U.S. Securities and Exchange Commission Form 424B filings, and the database includes coupon, broker fee, underlying asset, trigger share price, issuer, note identifier, issue date/maturity date, and bond size. This data set is supple-

[22]The U.S. Securities and Exchange Commission regulations such as the 1933 Securities Act restrict the marketing of financial products to retail investors.

[23]Egan (2019) has graciously shared his data on reverse convertible bonds.

mented with equity volatility data from Option Metrics and credit default swap, interest rates swap data from Bloomberg.

1.3.2 Data on Broker Firms

In the first data set, the data limitation is that one can only observe overall market level bond sizes and one does not observe how much each broker firm sells of each bond. To resolve this problem, I combine the first data with a second data set which provides information on the size of each broker firm. Specifically, the second data set includes the number of investment advisers employed by each broker firm on a yearly basis (2007-2015). [24] Overall, there are 32,178 broker firms and 2,703,637 observations. [25] From this, I make a list of 29 broker firms that sell reverse convertible bonds, as shown in Table 1.3. Each broker firm in the list is identified as a broker firm that sells reverse convertible bonds. As explained previously, the list includes a Barclays broker firm, a UBS broker firm, and a JP Morgan broker firm. A broker firm such as Edward Jones engages in the downstream broker firm market but does not issue reverse convertible bonds. These 29 broker firms constitute the downstream broker firms in the industry and employ 115,514 investment advisers on average each year, which accounts for 38.5% of all investment advisers in the market. Next, I construct a variable called a share of brokers which measures the relative number of investment advisers employed by each

[24] Egan, Matvos, Seru (2018) have graciously shared their data on broker firms.

[25] Source: the U.S. Securities and Exchange Commission's Investment Adviser Public Disclosure (IAPD) website. Available at `https://adviserinfo.sec.gov/`

broker firm as shown in Table 1.4. Each row shows each broker firm and each column shows the year of which the data is used. For instance, UBS Financial Services Inc. employed 8.38% of all the investment advisers selling reverse convertible bonds in 2012. When a number is higher, then it means a broker firm has a larger presence in the market in a given year.

1.4 Reverse Convertible Bond Pricing

In this section, I explain reverse convertible bond pricing. I start with a general approach. Then I provide a numerical example using a real data point. Next, I show summary statistics which includes information obtained by fair value calculation. Lastly, I calculate the probability of hitting a barrier for two different types of bonds.

1.4.1 General Approach

Information on coupons and broker fees is directly from the data but the challenge is that an issuer markup, i.e. how much an issuer earns by issuing a bond, is unknown. Thus, in order to calculate an issuer markup, I calculate the risk (fair value) of each bond by a replicating portfolio. This tells us how much an issuer receives by hedging the position on the date they issue a bond. To start with, by investing in a reverse convertible bond, an investor effectively enters a sell position of an equity put option. As seen in Figure 1.4, a broker firm does not take any positions and transfer it to an issuer. An investor has a sell position which means an issuer enters a buy position. In order to hedge, an issuer sells an equity option in the equity options market. The key question is how much an issuer receives by selling an equity option. Equity option prices are calculated according to Black and Scholes (1973) for a single observation type and according to Reiner and Rubinstein (1991a, 1991b) for a continuous observation type. Reiner and Rubinstein (1991a, 1991b) provide analytical forms for equity option prices of a continuous observation type. While implementing this, I assume that each underlying equity pays a constant dividend. Once the fair value is calculated, the difference between the risk (fair value) and the sum of coupon and broker fee is defined as an issuer markup. This is because the fair value is what an issuer receives by hedging the position while coupon and broker fee are what an issuer pays to an investor and a broker, respectively. Additionally, I also use the information on credit default swaps and interest rates swaps to account for the default risk of issuers.

1.4.2 Numerical Example

A numerical example of a reverse convertible bond pricing is provided using an example from Table 1.5. The bond is issued by a JP Morgan issuer on trade date 20 April 2012. The maturity date is 26 April 2013 which is one year from the trade date. A monthly coupon is 9.10% and the underlying asset is a Las Vegas Sands Corp stock price. A Las Vegas Sands Corp stock price is $58 when the bond is issued and the predetermined trigger share price is $40 which is 70% of the initial share price. A good benchmark to start with is the coupon yield without an equity option. A traditional bond issued by JP Morgan for the same trade date and maturity date pays investors 0.89%. Information on credit default swaps and interest rates swaps is used to obtain the value. The coupon difference between the reverse convertible bond 9.10% and the traditional bond 0.89% must come from an equity option premium. On trade date, 20 April 2012, the stock price of Las Vegas Sands Corp was $58. By selling an equity option, the investor receives an option premium. At option expiry date or maturity date, the investor is fully protected as long as the stock price stays above $40 as this is a single observation type bond. Once it hits $40, the investor loses 30% of her principal and her loss becomes even larger as the stock price goes down further down the road. This type of option is called a knock-in put option. Reiner and Rubinstein (1991a, 1991b) provide a tool for knock-in put option pricing. Based on the market conditions on the trade date, 20 April 2012, the option premium is trading at 12.40%. Now we are ready to calculate an issuer markup. By purchasing this bond, the investor is effectively taking two risks: a JP Morgan credit risk and a Las Vegas Sands Corp equity option risk. The market assesses them as 13.29% (= 0.89% + 12.40%), and the bond pays a coupon of 9.10% so 4.19% (= 13.29% − 9.10%) is a joint seller's margin for an issuer and a broker. The broker fee is fully disclosed and it is 2.00% so an issuer markup is 2.19% (= 4.19% − 2.00%). The seller's margin breakdown is summarized in Table 1.6. Risk (fair value) is 13.29% which is calculated by equity option pricing. Coupon 9.10% and broker fee 2.00% are directly from the first data set. So, the difference of 2.19% is an issuer markup for this bond. Similarly, I calculate an issuer markup for every bond in the data set.

1.4.3 Summary Statistics

Summary statistics for the bonds are shown in Table 1.7 including issuer markups. In order to calculate market shares, I define a market as the universe of all reverse convertible bonds each month since the marketing period is one month. Thus, the outside option is defined as the sum of all the reverse convertible bonds other than those with a one-year maturity. Each month is defined as a market and there are 5 years' data so there are 60 markets in the data. We have 3,066 observations and note that each observation corresponds to each reverse convertible bond issued in the market. Thus, the average number of bonds in each market is 51 and the average outside option share is 69.4%. The average bond pays a coupon of 10.51% with a standard deviation of 2.84%. Broker fees are 2.24% on average with a standard deviation of 0.69%. Issuer markups are on average 4.61% with a standard deviation of 6.43%. Note that the number of observations for issuer markups is 2,684 as information on credit default swaps is missing for some minor issuers. The risk or fair value is 17.07% on average with a standard deviation of 6.90%. The mean size of bonds is $1.44 million with a standard deviation of $2.20 million. One can see that these are fairly small-sized bonds compared to bonds purchased by institutional investors.

1.4.4 Probability of Hitting a Barrier

As explained, a bond investor's payoff depends on whether an underlying asset price hits a barrier or not so one may be curious about the probability of hitting a barrier for reverse convertible bonds. In this subsection, I derive the probability of hitting a barrier for two types of reverse convertible bonds - single observation vs. continuous observation. Out of 3,066 observations, single observation types accounts for 1,364 bonds while continuous observation types accounts for 1,702 bonds. First of all, for single observation reverse convertible bonds, we observe an underlying stock price only once at maturity. If the stock price is trading at equal or lower than the predetermined trigger share price, a bond investor incurs a huge loss in the principal. Using the Black-Scholes equity option pricing model, I calculate the probability of hitting a barrier for single observation types which is equivalent to calculating the probability that an equity put option will be exercised. The results show that the probability of hitting a barrier for single observation types is 0.28 on average. The median value is 0.29 and the histogram is shown in Figure 1.5. On the x-axis, it shows the probability of hitting a barrier and on the y-axis, it shows the number of bonds. Roughly speaking, investors investing in single observation type reverse convertible bonds incur a significant loss on their principal with probability 0.28 and they receive a high return with probability 0.72 without any loss in their principal. Again, this shows that reverse convertible bonds are high-risk high-return products.

Next, for continuous observation reverse convertible bonds, we observe an underlying stock price on a daily basis until maturity. If the stock price ever touches the predetermined trigger share price for any given day during the life of a bond, a principal is converted into equity. Using the Reiner and Rubinstein equity option pricing model, I calculate the probability of hitting a barrier for continuous observation types. In other words, I calculate the probability of an underlying stock price ever hitting the predetermined trigger share price during the life of a bond when observed on a daily basis. The exercise shows that the probability of hitting a barrier for continuous observation types is 0.57 on average. The median value is 0.58 and the histogram is shown in Figure 1.6. On the x-axis, it shows the probability of hitting a barrier and on the y-axis, it shows the number of bonds. Roughly speaking, investors investing in continuous observation type reverse convertible bonds are expected to witness their principal converting into equity with probability 0.57 and it is expected that their principal does not convert into equity with probability 0.43. Unlike a single observation type case, we need to be cautious when interpreting this result as this does not mean investors incur a loss in their principal with a probability of 0.57. Even when an underlying stock price hits a barrier and the principal is converted into equity, investors still enjoy a positive or high return when the stock price recovers before the maturity. This scenario is included in the probability of 0.57. Overall, I believe these two exercises show that investors face a higher probability of incurring a loss in their principal than expected.

1.5 Concluding Remarks

In this chapter, I document the institutional backgrounds of the reverse convertible bonds market. A reverse convertible bond has a complex payoff scheme so I explain it with a real example which is one observation from the data set. In terms of market structure, there are upstream issuers who issue bonds and downstream broker firms who buy bonds from issuers and sell them to investors. It is noteworthy that some issuers and brokers are financially integrated. Economic questions related to vertical incentives will be discussed in later chapters. The distribution process is also documented in this chapter whose industry model will be presented in the third chapter. The data on reverse convertible bonds are described and using the data set, I calculate the fair value of each bond by which I derive an issuer markup. This enables me to back out how much profit each issuer earns by issuing a bond. This variable plays a critical role in investigating vertical incentives in the market in later chapters. Finally, I discuss the summary statistics of my data set and calculate the probability of hitting a barrier for both types of bonds.

Issuer	JP Morgan
Trade Date	08/26/2008
Maturity Date	08/28/2009
Coupon	10%
Underlying Asset	Apple Inc.
Initial Share Price	$173
Trigger Share Price	$104 (60%)

Table 1.1: Reverse Convertible Bond Example

Rank	Underlying Asset	Number of Bonds
1	Apple Inc.	198
2	Bank of America Corporation	97
3	Caterpillar Inc.	78
4	General Electric Company	75
5	JP Morgan Chase & Co	75
6	Freeport-Mcmoran Inc.	70
7	United States Steel Corporation	62
8	Ford Motor Company	53
9	Alpha Natural Resources Inc.	51
10	Citigroup Inc.	48

Table 1.2: The Most Popular Underlying Assets

ABN AMRO Asset Management, Inc.
Ameriprise Advisor Services, Inc.
Ameriprise Financial Services, Inc.
Barclays Capital Inc.
Bear, Stearns & Co. Inc.
BMO Harris Financial Advisors, Inc.
Capitol Securities Management, Inc.
Charles Schwab & Co., Inc.
Citigroup Global Markets Inc.
Credit Suisse Securities (USA) LLC
Deutsche Bank Securities Inc.
Edward Jones
Ferris, Baker Watts, LLC
H&R Block Financial Advisors, Inc.
HSBC Securities (USA) Inc.
J.P. Morgan Securities LLC
Landolt Securities, Inc.
Lehman Brothers Inc.
Merrill Lynch Pierce Fenner & Smith Inc.
Morgan Stanley
Morgan Stanley & Co. Inc
Morgan Stanley Smith Barney LLC
Raymond James Financial Services
RBC Capital Markets Corp
Santander Securities
TD Ameritrade, Inc.
UBS Financial Services Inc.
Wachovia Securities, LLC
Wells Fargo Investments, LLC

Table 1.3: List of 29 Broker Firms Who Sell Reverse Convertible Bonds

	2008	2009	2010	2011	2012	Average
Barclays Capital Inc.	0.00%	0.45%	0.50%	0.50%	0.53%	0.40%
UBS Financial Services Inc.	9.19%	8.87%	8.01%	8.10%	8.38%	8.51%
J.P. Morgan Securities LLC	0.53%	0.91%	0.95%	0.96%	1.03%	0.88%
Others	90.28%	89.77%	90.54%	90.44%	90.06%	90.21%

Table 1.4: A Share of Brokers Employed by Each Broker Firm

Issuer	JP Morgan
Trade Date	04/20/2012
Maturity Date	04/26/2013
Coupon	9.10%
Underlying Asset	Las Vegas Sands Corp
Initial Share Price	$58
Trigger Share Price	$40 (70%)

Table 1.5: Reverse Convertible Bond Pricing Example

Risk (Fair Value)	13.29% (=0.89%+12.40%)
Coupon	9.10%
Seller's Margin (Issuer Markup/Broker Fee)	4.19% (=13.29%-9.10%)
Broker Fee	2.00%
Issuer Markup	2.19% (=4.19%-2.00%)

Table 1.6: Seller's Margin Breakdown

Number of markets:	60		
Number of total bonds:	3,066		
Number of bonds each market:	51		
% of outside option:	69.4%		
	Observations	**Mean**	**Stdev**
Coupon (c)	3,066	10.51%	2.84%
Broker Fee (κ)	3,066	2.24%	0.69%
Issuer Markup (η)	2,684	4.61%	6.43%
Risk (Fair Value) (v)	2,684	17.07%	6.90%
Size (in USD millions)	3,066	1.44mm	2.20mm

Table 1.7: Summary Statistics

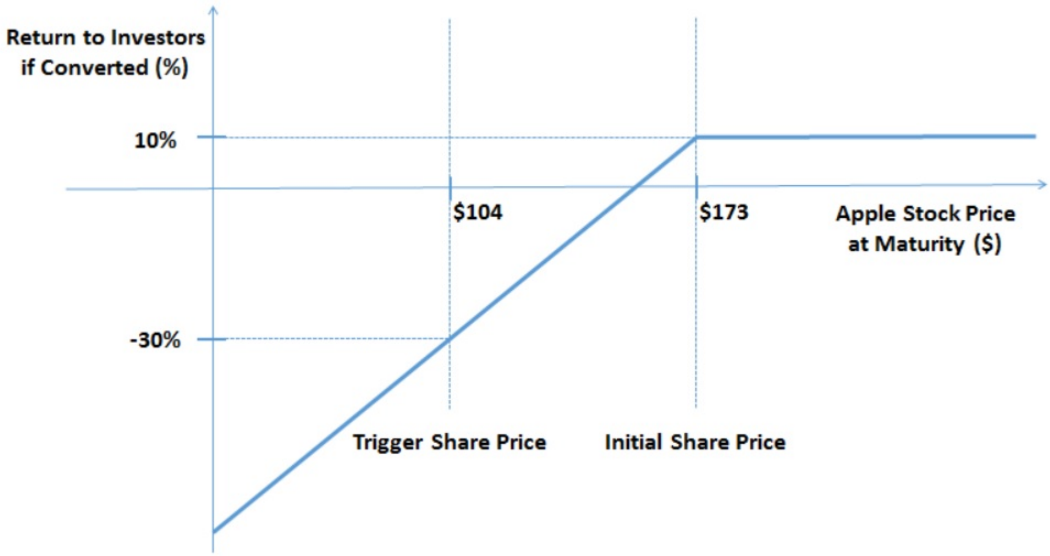

Figure 1.1: Reverse Convertible Bond Payoff If Converted (Scenario 2)

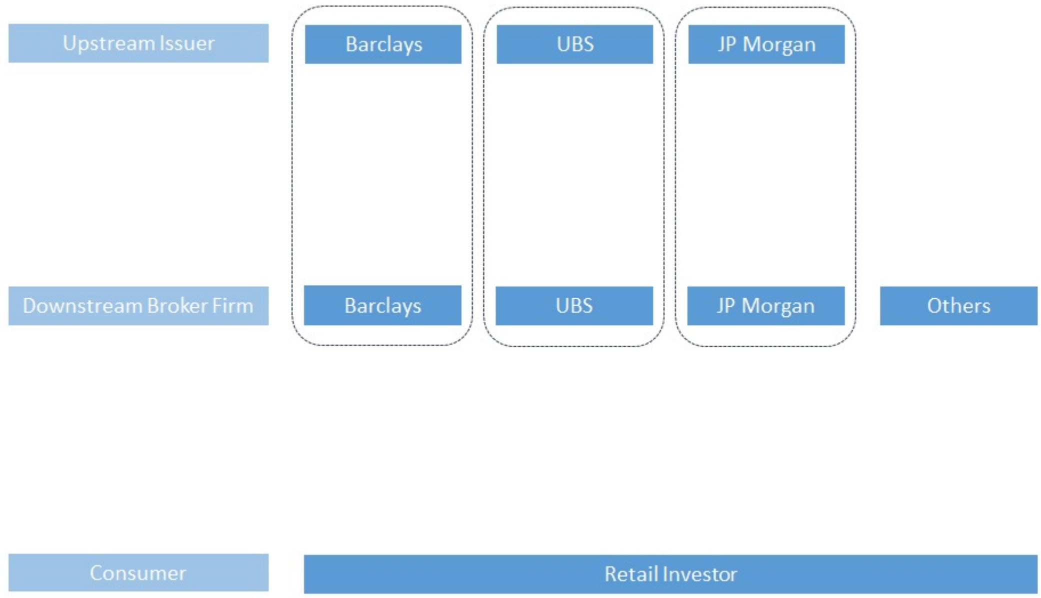

Figure 1.2: Market Structure

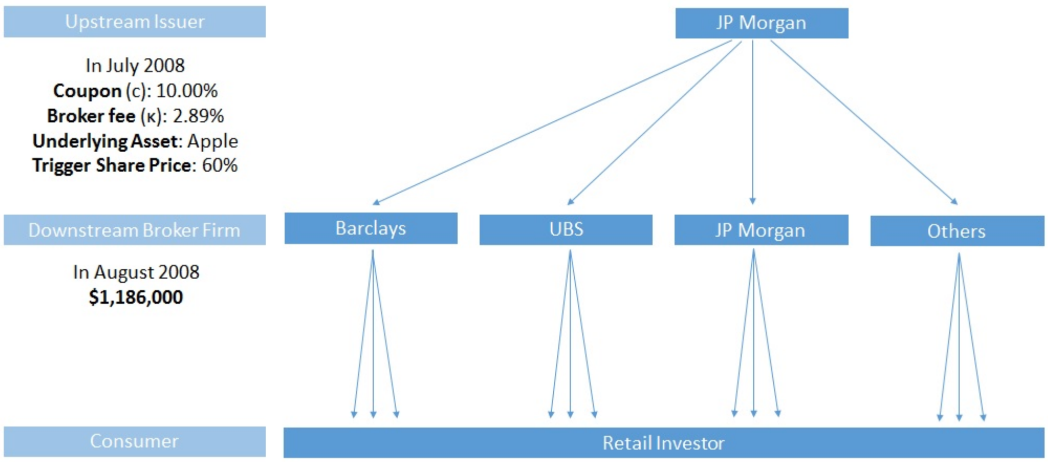

Figure 1.3: Distribution Process

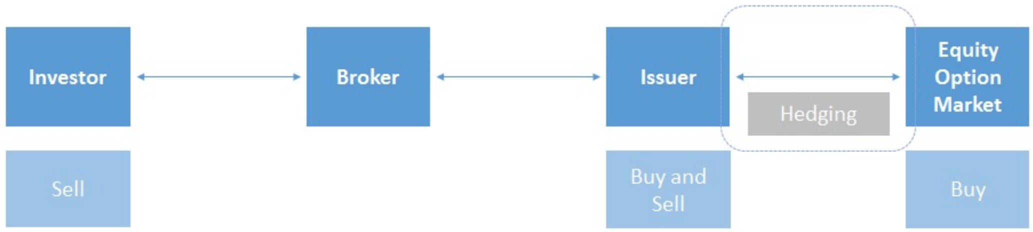

Figure 1.4: Hedging Through Equity Option Market

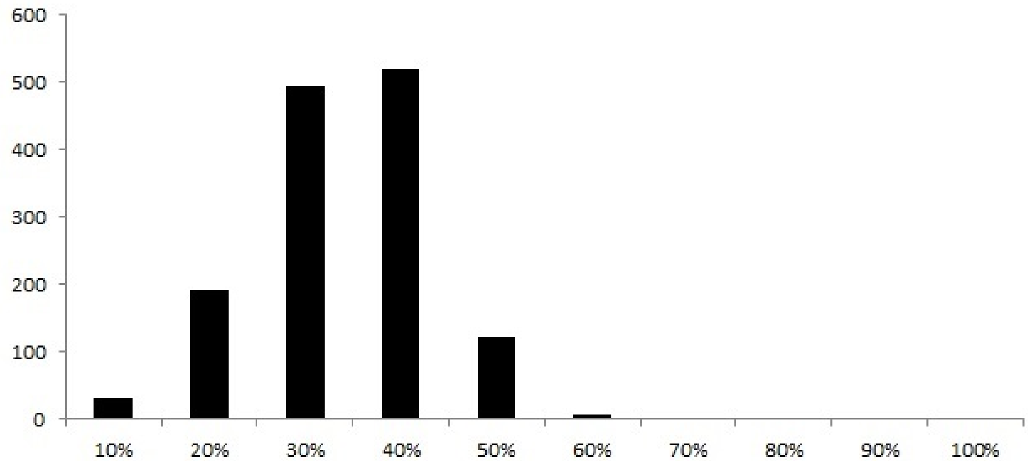

Figure 1.5: Probability of Hitting a Barrier for Single Observation Type

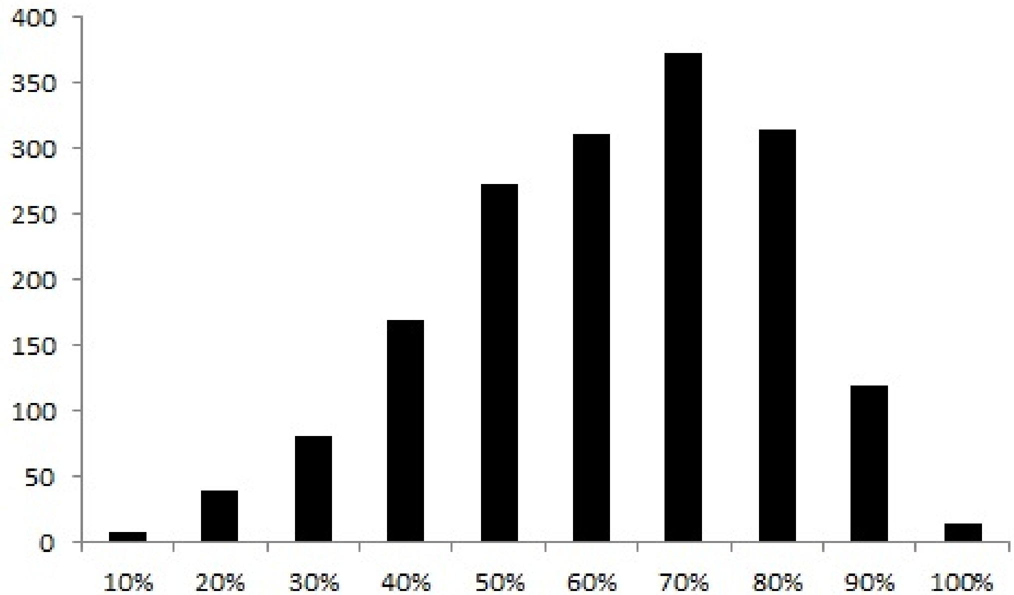

Figure 1.6: Probability of Hitting a Barrier for Continuous Observation Type

Chapter 2

Agency Problems and Vertical Incentives: Evidence from Reverse Convertible Bonds Market

2.1 Introduction

2.1.1 Research Question

In many cases, consumers rely on experts when they select a product. In financial markets, for instance, investors seek financial advice from brokers. Similarly, in prescription drug markets, physicians prescribe drugs for their patients. However, experts may have different incentives from those of consumers, which is known as a conflict of interest. A further complication is that there are usually informational asymmetries between experts and consumers. In other words, experts understand the products and markets better than consumers, and so it is possible for them to steer their consumers into certain products to maximize their own profits rather than taking care of the consumers, creating agency problems. Thus, there are regulations that have been imposed, such as requiring advisors to act as fiduciaries, to prevent agency problems. In this chapter, I investigate agency problems in the context of financial intermediaries. Specifically, I study agency problems by analyzing financial brokers in the U.S. reverse convertible bonds market.

The U.S. reverse convertible bonds market is explained and documented in the first chapter. In observing the market, one may notice that this product has caused many problems for retail investors. In 2016, UBS Financial Services paid $15 million to settle charges in connection with the sale of reverse convertible bonds, as 8,700 retail investors were given unsuitable recommendations of the bonds. The U.S. Securities and Exchange Commission mentioned that it failed to adequately educate and train its sales force about certain complex financial products it sold to retail investors. [1] In 2015, RBC Capital Markets also paid a $1 million fine for supervisory failures resulting in sales of unsuitable reverse convertible bonds to its retail investors. [2] In 2011, Wells Fargo Investments was fined $2 million for unsuitable reverse convertible bond sales to elderly customers. [3] In 2010, the Financial Industry Regulatory Authority fined H&R Block Financial Advisors $200,000 for failing to establish adequate procedures for supervising sales of reverse convertible bonds to its retail investors. [4] It is hard to imagine that a high-risk, high-return product like a reverse convertible bond is a suitable product for senior citizens or retired couples, who should prefer stable and modest sources of income. However,

[1] Source: the U.S. Securities and Exchange Commission website. Available at `https://www.sec.gov/news/pressrelease/2016-197.html`

[2] Source: Financial Industry Regulatory Authority website. Available at `https://www.finra.org/media-center/news-releases/2015/finra-orders-rbc-pay-fine-and-restitution-totaling-more-14-million`

[3] Source: Financial Industry Regulatory Authority website. Available at `https://www.finra.org/media-center/news-releases/2011/finra-fines-wells-fargo-2-million-unsuitable-sales-reverse-convertibles`

[4] The MarketWatch website. Available at `https://www.marketwatch.com/story/regulator-fines-hr-block-200k-for-poor-controls-2010-02-16`

brokers at Wells Fargo Investments recommended and sold reverse convertible bonds to senior citizens who were over 80 years old and brokers at H&R Block Financial Advisors sold them to a retired couple.

An immediate question one might have is why retail investors are buying reverse convertible bonds. A reverse convertible bond pays a particular type of payoff, so some investors may prefer them depending on their portfolios. Another reason could be that retail investors are misled by high coupons, especially in a low-yield environment. From the data set used in this chapter, reverse convertible bonds pay 10.51% coupons on average, which may appear attractive to retail investors. However, although it pays a high coupon, the total return can be negative if the underlying asset price falls. A bond investor receives a high return only when the underlying asset price remains high. A relevant article titled "Risky Strategy Lures Investors Seeking Yield - Popular 'Reverse Convertibles' Offer Lucrative Payouts But Could Cause Steep Losses" was published in the Wall Street Journal in 2008. [5] In addition, this product has a complex structure, so it may be hard for retail investors to value the risk associated with it. A 10.51% coupon may seem attractive, but it also bears a significant risk; however, retail investors may not be sophisticated enough to properly evaluate that risk. For example, in order to assess the risk, one needs to calculate the fair value of the bonds using the Black-Scholes option pricing model, which is not something many retail investors will be in a position to

[5]Source: The Wall Street Journal website. Available at `https://www.wsj.com/articles/SB120648718371963833`

understand and apply when they are making their investment decisions. Recommendations by brokers must also be considered. From the data set used in this chapter, the seller's margins for reverse convertible bonds are almost 7% on average, so it is possible for brokers to recommend these products in order to earn high commissions or fees. While it may seem difficult to understand why retail investors would buy these bonds, there are many retail investors who engage in this market. In terms of market size, this bond market exceeded 10 billion dollars in the U.S. and over 50 billion dollars globally in 2008. [6] Even though retail investors are active in this market, the product has a complex structure that is hard to understand.

In the reverse convertible bond market, it is not surprising that retail investors mainly rely on financial advisers to decide which product to purchase since the products have such a complex structure. In order to sell reverse convertible bonds in the US, one needs to possess either a broker's or investment adviser's license. Brokers are regulated by the Financial Industry Regulatory Authority and are held to a suitability standard, which states, "Financial Industry Regulatory Authority Rule 2111 requires that a member or an associated person must have a reasonable basis to believe that a recommended transaction or investment strategy involving a security or securities is suitable for the customer, based on the information obtained through the reasonable diligence of the member or associated person to ascertain the customer's in-

[6] Laise (2008), Alloway (2015)

vestment profile." [7] Meanwhile, investment advisers are regulated by the U.S. Securities and Exchange Commission and are held to the following fiduciary standard: "As fiduciaries, investment advisers are required to act in the best interest of clients and to not place their own interests ahead of their clients." [8] If brokers behave as the regulations require, one may believe that they are giving the best possible advice regarding this set of products. However, there is a conflict of interest that can arise in this market. The data set considered in this chapter shows that a lower coupon is associated with a higher broker fee on average, holding everything else fixed, which suggests that a bond whose product characteristics are less attractive to retail investors may pay higher fees to brokers.

As there are many issues regarding the bond sales practices of various broker firms, it is questionable whether existing regulations are accomplishing their desired goals. Thus, a natural question that arises is whether the advice investors get from their brokers is affected by their conflicting incentives. In other words, we want to understand whether there are agency problems or not in the reverse convertible bond market. If brokers appear to follow the relevant regulations and try to act in the best interests of their investors, then one does not need to be overly concerned about this market. Otherwise, this may be an area that needs more regulation.

[7] Source: the Financial Industry Regulatory Authority website. Available at `https://www.finra.org/rules-guidance/rulebooks/finra-rules/2111`

[8] Source: Investment Adviser Association website. Available at `https://www.investmentadviser.org/home/side-content/sec-standard`

In addition to agency problems, vertical incentives may also affect agency problems if brokers are vertically integrated with their upstream firms. For instance, in this market, JP Morgan brokers not only sell JP Morgan-issued products but also UBS-issued products, and they may behave differently depending on which products they are selling. Although arms-length transaction regulations exist in the market, which requires that vertical relationships not influence broker activities, brokers may have incentives to consider their vertically integrated firm's profits. As expected, using two data sets, I show that brokers are sensitive to the markups of their vertically integrated upstream firm.

2.1.2 Contributions to the Literature

This chapter contributes to the vertical integration literature by combining agency problems and vertical integration (Crawford, Lee, Whinston and Yurukoglu 2018). While Crawford, Lee, Whinston, and Yurukoglu (2018) analyze vertical integration only, this chapter shows that vertical incentives and agency problems both affect financial broker activities. Also, it is related to the topic of price dispersion in financial markets (Choi, Laibson and Madrian 2010; Hortacsu and Syverson 2004; Massa 2000; Green and Hollifield 1992) by discussing two identical financial products with different prices. It is also related to structured products (Henderson and Pearson 2011; Szymanowska, Horst and Veld 2009; Bergstresser 2008; Benet, Giannetti and Pissaris 2006; Stoimenov and Wilkens 2005) as reverse convertible bonds belong to structured products. Lastly, it is related to consideration sets (Crawford, Griffith and Iaria 2016; Goeree 2008) by showing brokers limit the available financial products offered to their investors.

In this chapter, I mainly document stylized facts using a reduced-form analysis. One can see that there is suggestive evidence of agency problems and vertical incentives. The remainder of the chapter is organized as follows. Section 2 describes the data. Section 3 shows there exists a conflict of interest in the market. In Section 4, I show some evidence of agency problems while in Section 5, I show evidence of vertical incentives. Section 6 concludes the chapter.

2.2 Data

Two data sets used in this chapter are described in the first chapter.

2.3 Conflict of Interest

If higher broker fees are associated with low coupons after controlling for other characteristics, then this suggests a conflict of interest since bonds that are less attractive to investors pay higher fees to brokers. In order to test this, I consider the following equation.

$$\text{coupon}_j = \beta_0^a \,\text{broker fee}_j + \beta_1^a \,\text{risk}_j + \beta_2^a \,\text{controls}_j + \epsilon_j^a, \tag{2.1}$$

where j indexes each bond and we are interested in whether or not

$\beta_0^a < 0$. For controls, I add a dummy variable for continuous observation, market fixed effects, issuer fixed effects, and equity fixed effects. First of all, there are two types of reverse convertible bonds - single observation and continuous observation. By adding a dummy variable for a continuous observation which equals to 1 if a continuous observation or 0 otherwise, I control for two types of reverse convertible bonds. Secondly, each month is defined as a different market. If a market shock makes this month fundamentally different from the previous month, then the market fixed effects will control for that. Thirdly, for example, investors who purchase JP Morgan-issued bonds may be fundamentally different from investors who buy UBS-issued bonds. In this case, issuer fixed effects will control for that. Lastly, if investors who purchase Apple stock-linked bonds are fundamentally different from those who purchase IBM stock-linked bonds, then equity fixed effects can control for that.

The results are presented in Table 2.1 where I add market fixed effects and issuer fixed effects for the first specification and I add equity fixed effects additionally for the second specification. There are 2,684 observations for both specifications and the R-squared for the first specification is 0.1343 while the R-squared for the second specification is 0.1799. The estimate on the broker fee coefficient for the first specification is -0.1386 and the estimate on the broker fee coefficient for the second specification is -0.1358. They suggest that higher broker fees are associated with lower coupons on average, holding other factors fixed. The signs of the coefficients are all negative and statistically significant. In terms of magnitude, a 1 percentage point increase in broker fee is associated with a 0.14% decrease in coupon on average. The coefficient estimate on risk is 0.2871 for the first specification and 0.2723 for the second specification. Both of them are positive and statistically significant. When a bond is riskier, investors demand a higher coupon, so this is in line with what we expect. The coefficient estimate on a continuous observation dummy variable is 0.0024 for the first specification and 0.0028 for the second specification. Both of them are positive although statistically not significant. In sum, this shows that there is a potential conflict of interest in these products.

One may also think about the relationship between a coupon and a seller's margin where a seller's margin is defined as the sum of an issuer markup and a broker fee. If an increase in the seller's margin is associated with the lower coupon, then this may also suggest a conflict of interest. However, the sum of a coupon and a seller's margin equals a fair value so this relationship is mechanical. If I had run regressions controlling for fair values, then the regressions suffer from the perfect multi-collinearity problem.

2.4 Testing Agency Problems

In this section, I test whether there are agency problems or not. The first evidence of agency problems is that there exist strictly dominating and dominated product pairs in the same market. Secondly, I show that high broker fee products get sold more than low broker fee products do.

2.4.1 Superior and Dominated Bond Pairs

Given that there is a conflict of interest, I now document suggestive evidence of agency problems. [9] Table 2.2 compares two reverse convertible bonds. Note that column (2) in the table shows the reverse convertible bond that I presented as an example in the first chapter. CUSIP is a unique identifier for each bond so different CUSIPs tell us they are two different bonds. A JP Morgan issuer issued both bonds and trade date and maturity date are the same 26 August 2008 and 28 August 2009, respectively. Face values are the same (100 for both bonds) and underlying assets are the same Apple stock. Moreover, the initial share price and trigger share price are the same \$173 and \$104, respectively. However, the coupon is not the same. This is surprising as this tells us that there is another bond that has the same product characteristics but with a higher coupon, as shown in column (1). I call the bond with a higher coupon a superior bond and the bond with a lower coupon a dominated bond. Superior and dominated bonds are cheap and expensive versions, respectively, of otherwise identical bonds. Superior and dominated bonds not only have the same product characteristics but also have the same issuer, and most importantly, they are sold on the same trade date. Since superior bond and dominated bond share the same product characteristics other than the coupon, risks are the same 14.12%. But one may notice that the dominated bond pays a lower coupon but a higher broker fee and a higher issuer markup in Table 2.2. This, again, shows a conflict of interest as we

[9]The analysis in this subsection is very similar to Egan (2019).

discussed in the previous section. Comparing the sizes of the two bonds, the dominated bond with a higher broker fee was sold 20 times more frequently than the superior bond with a low broker fee. This suggests informational frictions since no investor would ever prefer the dominated bond over the superior bond. This also suggests agency problems as no broker would offer the dominated bond if he were to maximize investor profit alone.

Another interesting example is shown in Table 2.3. This time a UBS issuer issues 7 different bonds on the same trade date 27 March 2012 with the same maturity date 4 April 2012. ISIN is a unique identifier for each bond, similar to CUSIP. Different ISINs show they are different bonds. Face values are both 100 and they have the same underlying asset of a Hewlett-Packard stock price. Initial share prices are the same at \$23.62 and trigger share prices are also the same at \$20.08. However, not all coupons are the same. Bond 1 and Bond 2 pay the highest coupon as 8.32% while Bond 6 and Bond 7 pay the lowest coupon as 8.06%. Bond 3, Bond 4 and Bond 5 pay coupons lower than Bond 1 and Bond 2 do but higher than Bond 6 and Bond 7 do. In other words, investors who invest in these bonds all take the same risks but returns are not the same.

Previous two examples are not just anecdotal cases, as superior and dominated bond pairs are observed repeatedly in the data set. I extend a similar analysis of Table 2.2 to all superior and dominated bond pairs, which account for 244 bonds out of 3,066 bonds (8.0%) in my data, as shown in Table 2.4. Superior bonds pay 10.76% coupon while dominated bonds pay

9.65% coupon on average. Superior bond coupon is higher than dominated bond coupon by definition. As superior and dominated bond pairs share the same product characteristics, risks are the same, 18.89% on average. The broker fee of superior bonds is 1.46% while the broker fee of dominated bonds is 2.16% on average. As expected, the average broker fee of dominated bonds is higher than the average broker fee of superior bonds. The issuer markup of superior bonds is 6.69% on average while the average issuer markup of dominated bonds is 7.08%. Similarly, issuers make more profit by issuing dominated bonds compared to issuing superior bonds. Finally, the average size of superior bonds is $578k while the average size of dominated bonds is $733k. In sum, low coupon-paying dominated bonds offer higher broker fees and they not only get sold but they get sold more than superior bonds do on average. Another point worth mentioning is that dominated bonds are not offered by one specific issuer. To the contrary, all three major issuers - Barclays, UBS, JP Morgan - issue and sell dominated bonds.

2.4.2 High Fee Products vs. Low Fee Products

Next, we compare high broker fee products and low broker fee products. After we control for the sum of issuer markups and broker fees (I will call this the seller's margin), broker fees should not affect demand for bonds because they simply show a division of surplus between issuers and brokers. For instance, when an issuer markup is 5% and a broker fee is 2%, what investors care about will be the sum 7%. After we control for 7%, investors will not be affected by a 2% broker fee, as this only shows how issuers and broker firms split their margins. In this spirit, consider the regression below where we control for coupon and risk (fair value), which means we control for the sum of issuer markup and broker fee. If we add broker fee into the regression after controlling for coupon, risk (fair value) and controls, it should not affect bond sales theoretically.

$$\text{bond sales}_j = \beta_0^b \, \text{broker fee}_j + \beta_1^b \, \text{coupon}_j + \beta_2^b \, \text{risk}_j + \beta_3^b \, \text{controls}_j + \epsilon_j^b \quad (2.2)$$

Here bond sales_j is the size of bond j and the main question is whether or not $\beta_0^b > 0$. Note that a bond issuance practice in the reverse convertible bond market is different from that of bonds issued targeting institutional investors. When financial institutions issue a bond targeting institutional investors, they usually set a bond size in advance. This means a bond size, how much an issuer wants to issue, is one of the product characteristics. However, as we have seen in the first chapter, issuers in the reverse convertible bond market do not fix bond sizes in advance. Instead, they fix an issuer markup in advance and issue a bond which perfectly matches demand. This practice enables me to run the regression considered here. For controls, I add a dummy variable for continuous observation to account for two different types of bonds - single observation and continuous observation. I also add issuer fixed effects, and equity fixed effects. If investors investing in bonds issued by different issuers are fundamentally different, then issuer fixed effects will control for that. If investors investing in bonds linked to different underlying assets are fundamentally different, then equity fixed effects will control for that. The fixed effects regression results are presented in Table 2.5. The difference between the first column and the second column is whether you add equity fixed effects or not. The coefficient estimate on the broker fee is 14.6428 for the first specification and 14.5114 for the second specification. This means that in all specifications, broker fees positively affect bond sales or demand in a statistically significant way after controlling for the product characteristics. In terms of magnitude, when a broker fee increases by 1 percentage point, there is a 15% increase in a bond sales on average. The coefficient estimate on the coupon is 1.6450 under the first specification while it is 2.0654 under the second specification. Everything else equal, higher coupons will attract more investors so this is expected. Both estimates are statistically significant. The coefficient estimate on risk is -0.7071 for the first specification and -0.6761 for the second specification. Likewise, riskier bonds will attract fewer investors on average so both signs are expected. They are also statistically significant. The estimate on a continuous observation dummy variable is -1.3932 for the first specification and -1.4018 for the second specification. We have 2,684 observations in total for both specifications. The R-squared for the first specification is 0.4326 and the R-squared for the second specification is 0.4357. One could interpret the results as indicating that brokers recommend high broker fee products more often, meaning these products get more exposure to investors (which yields higher demand). The results that high broker fee bonds get sold more than low broker fee bonds on average suggest agency problems, especially when coupled with previous results that higher broker fee products are associated with low coupons.

2.5 Testing Vertical Incentives

In this section, I test whether there are vertical incentives in the supply chain or not. First, I show that vertical relationships affect bond sales. Second, I also show that vertical relationships affect upstream firm pricing.

2.5.1 Share of Brokers vs. Bond Sales

I show some evidence of vertical incentives between upstream issuers and downstream brokers. First, consider downstream broker activities. If there were no vertical relationships, which are required by the arms-length transaction regulation, the share of brokers at a vertically integrated downstream firm should not affect the demand for bonds issued by an upstream firm. For example, the share of brokers at the downstream UBS broker firm should not affect demand for the upstream UBS-issued bonds if there were no vertical incentives. To test vertical incentives based on this logic, I consider the following regression equation.

$$\text{bond sales}_j = \beta_0^c \,\text{broker fee}_j + \beta_1^c \,\text{share of brokers}_j + \beta_2^c \,\text{coupon}_j + \beta_3^c \,\text{risk}_j + \beta_4^c \,\text{controls}_j + \epsilon_j^c, \tag{2.3}$$

where share of brokers$_j$ is the relative number of brokers at a downstream broker firm that is vertically integrated with an issuer who issues bond j. Based on the regressions we considered in the previous section, we add this new variable share of brokers. If there are no vertical incentives, then β_1^c will be close to zero. For controls, I add a continuous observation dummy variable, issuer fixed effects, and equity fixed effects. The fixed effects regressions are presented in Table 2.6. Equity fixed effects are not added in the first fixed effects regression while they are added in the second fixed effects regression. The coefficient estimate on the share of brokers is 6.9244 for the first specification and 6.9831 for the second specification. They are both positive and statistically significant after controlling for coupon, risk (fair value), broker fee, and controls. In terms of magnitude, when the share of brokers increases by 1 percentage point, there is a 7% increase in a bond sales. The coefficient estimate on the broker fee is 19.9427 under the first specification while it is 19.7750 under the second specification. The results are in line with the results in Table 2.5 as broker fees positively affect bond sales. The coefficient estimate on coupon is 2.1834 without equity fixed effects and 2.5310 with equity fixed effects. They are positive and statistically significant as expected. The estimate on the risk coefficient is -0.6954 for the first column while it is -0.6634 for the second column. They are negative and statistically significant as investors prefer less risk, holding others fixed. The estimate on the continuous observation coefficient is -1.4923 for the first specification and -1.5047 for the second specification. 2,542 observations are used in regressions and the R-squared is

0.4369 for the first column while it is 0.4410 for the second column. What we learn from this exercise is that the variable share of brokers positively affects bond sales after controlling for others. One can interpret the results as the downstream brokers attempting to sell more of their vertically integrated upstream parent firm's products compared to their vertically non-integrated upstream competitor firm's products. In other words, this suggests that a JP Morgan broker firm tries to sell more of JP Morgan issued bonds compared to UBS issued bonds all else equal.

2.5.2 Upstream Price-Setting

In this subsection, consider price-setting behaviors of upstream issuers. If there were no vertical relationships, which is a requirement under the arms-length transaction regulation, the share of brokers at vertically integrated downstream firms should not affect price settings at upstream firms. For instance, the share of brokers at the downstream UBS broker firm should not affect how the upstream UBS issuer sets prices if there were no vertical relationships. Consider the following equations with multiple dependent variables: coupon, broker fee, and issuer markup.

$$\text{coupon}_j = \beta_0^d \,\text{share of brokers}_j + \beta_1^d \,\text{risk}_j + \beta_2^d \,\text{controls}_j + \epsilon_j^d, \tag{2.4}$$

$$\text{broker fee}_j = \beta_0^e \,\text{share of brokers}_j + \beta_1^e \,\text{risk}_j + \beta_2^e \,\text{controls}_j + \epsilon_j^e, \tag{2.5}$$

$$\text{issuer markup}_j = \beta_0^f \,\text{share of brokers}_j + \beta_1^f \,\text{risk}_j + \beta_2^f \,\text{controls}_j + \epsilon_j^f, \tag{2.6}$$

where coefficients of interest are β_0^d, β_0^e, and β_0^f. For controls, a dummy variable for a continuous observation, issuer fixed effects, equity fixed effects are added. The results of 6 fixed effects regressions are present in Table 2.7. When a dependent variable is a coupon, the first and the second column show the results without equity fixed effects and with equity fixed effects, respectively. When a dependent variable is a broker fee, the third and the fourth column show the results without equity fixed effects and with equity fixed effects, respectively. In the same manner, when a dependent variable is an issuer markup, the fifth and the sixth column show the results without equity fixed effects and with equity fixed effects, respectively.

With the dependent variable coupon, the coefficient estimate on the share of brokers is -0.1277 for the first specification and -0.1080 for the second specification. This means that when there is a higher share of brokers downstream, upstream issuers set coupons low, or prices high. The coefficient estimate on risk is 0.1448 for the first specification and 0.1171 for the second specification. They are both statistically significant and they suggest higher risks are compensated with higher coupons on average. The coefficient estimate on the continuous observation variable is 0.0040 and 0.0063, respectively. There are 2,542 observations in total. The R-squared is 0.1651 for the first specification and it is 0.2381 for the second specification. With the dependent variable broker fee, the coefficient estimate on the share of brokers is -0.0030 for the first specification and -0.0024 for the second specification. Both of them are very small in terms of magnitude and they are not statistically significant. This means that when there is a higher or lower share of brokers at the downstream market, upstream issuers change broker fees little. The coefficient estimate on risk is -0.0000 for the first specification and -0.0019 for the second specification. This shows that issuers do not change their broker fee setting behaviors according to the riskiness of bonds. Neither of these estimates are statistically significant. The coefficient estimate on the continuous observation variable is 0.0090 and 0.0092, respectively. There are 2,542 observations in total. R-squared is 0.3368 for the first specification and it is 0.3439 for the second specification. Lastly, with the dependent variable issuer markup, the coefficient estimate on the share of brokers is 0.1308 for the first specification and 0.1105 for the second specification. This means that when there is a higher share of brokers at the downstream market, upstream issuers set issuer markups high. In other words, they set their margins high when they have better distribution channels. The coefficient estimate on risk is 0.8551 for the first specification and 0.8848 for the second specification. These estimates suggest that issuers earn higher markups when they issue riskier bonds. The coefficient estimate on the continuous observation variable is -0.0131 and -0.0156, respectively. There are 2,542 observations in total. The R-squared is 0.8503 for the first specification and it is 0.8629 for the second specification. To summarize, the results show that when there is a higher share of brokers at the downstream market, after controlling for risk (fair value) and other controls, upstream issuers set coupons low and issuer markups high, while there is almost no change in broker fees. In terms of magnitude, when the share of brokers increases by 1 percentage point, the coupon decreases by 0.11 percentage points. Low coupons mean high prices, so upstream issuers raise prices when they have a better distribution channel in the downstream market. If there were no vertical relationship, it is hard to imagine that upstream issuers would change their price-setting patterns when the share of brokers increases in downstream markets.

2.6 Concluding Remarks

In this chapter, I document some evidence of agency problems and vertical incentives in the reverse convertible bonds market. To begin with, I show that lower coupons are associated with higher broker fees which suggests there is a conflict of interest. In terms of agency problems, I show two pieces of evidence. One is that in this market, strictly dominated products not only get sold but they get sold more than strictly dominating products. The other piece of evidence is that high broker fee products get sold more than low broker fee products after controlling for all other product characteristics which affect investor utility. Regarding vertical incentives, I show that vertical relationships not only affect bond sales but also upstream firms' price-setting patterns. While these findings suggest that there are agency problems and vertical incentives in the market, they are not very informative about the magnitudes. In order to figure out how severe agency problems and vertical incentives are, I present and estimate a structural model in the third chapter. The estimation results not only suggest there are agency problems and vertical incentives but they also suggest the magnitudes are severe.

Coupon	**FE1**	**FE2**
Broker Fee	-0.1386*	-0.1358*
	(0.0763)	(0.0725)
Risk (Fair Value)	0.2871***	0.2723***
	(0.0078)	(0.0082)
Continuous Observations	0.0024	0.0028
	(0.0020)	(0.0019)
Market Fixed Effects	X	X
Issuer Fixed Effects	X	X
Equity Fixed Effects		X
Observations	2684	2684
R-squared	0.1343	0.1799

Table 2.1: Broker Fee and Coupon

Bond	**1**	**2**
CUSIP	48123LLN2	48123LLA0
Issuer	JP Morgan	JP Morgan
Trade Date	08/26/2008	08/26/2008
Maturity Date	08/28/2009	08/28/2009
Face Value	100	100
Coupon	12.25%	10.00%
Underlying Asset	Apple Inc.	Apple Inc.
Initial Share Price	$173	$173
Trigger Share Price	$104	$104
Coupon	12.25%	10.00%
Broker Fee	1.65%	2.89%
Issuer Markup	0.22%	1.23%
Risk (Fair Value)	14.12%	14.12%
Size	55k	1,186k

Table 2.2: Superior and Dominated Bond Pairs 1

Bond	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Issue ISIN	4630	4713	5058	5132	5470	4895	4978
Issuer	UBS	UBS	UBS	UBS	UBS	UBS	UBS
Trade Date	03/27/2012	03/27/2012	03/27/2012	03/27/2012	03/27/2012	03/27/2012	03/27/2012
Maturity Date	04/04/2013	04/04/2013	04/04/2013	04/04/2013	04/04/2013	04/04/2013	04/04/2013
Face Value	100	100	100	100	100	100	100
Coupon	8.32%	8.32%	8.08%	8.08%	8.07%	8.06%	8.06%
Underlying Asset	HP	HP	HP	HP	HP	HP	HP
Initial Share Price	$23.62	$23.62	$23.62	$23.62	$23.62	$23.62	$23.62
Trigger Share Price	$20.08	$20.08	$20.08	$20.08	$20.08	$20.08	$20.08
Size	200k	100k	200k	100k	200k	100k	100k

Table 2.3: Superior and Dominated Bonds Pairs 2

Bond	**Superior Bond**	**Dominated Bond**
Coupon	10.76%	9.65%
Broker Fee	1.46%	2.16%
Issuer Markup	6.69%	7.08%
Risk (Fair Value)	18.89%	18.89%
Size	578k	733k

Table 2.4: Superior and Dominated Bond Pairs 3

log(Size) (USD 1k)	**FE1**	**FE2**
Broker Fee	14.6428***	14.5114***
	(3.8450)	(3.8924)
Coupon	1.6450**	2.0654**
	(0.8219)	(0.9032)
Risk (Fair Value)	-0.7071**	-0.6761*
	(0.3320)	(0.3680)
Continuous Observations	-1.3932***	-1.4018***
	(0.1129)	(0.1179)
Issuer Fixed Effects	X	X
Equity Fixed Effects		X
Observations	2684	2684
R-squared	0.4326	0.4357

Note: Bond size is measured in USD 1,000. Robust standard errors are reported in parentheses. ** and *** indicate significance at the 5% and 1% levels, respectively.

Table 2.5: Broker Fee and Bond Size

log(Size) (USD 1k)	**FE1**	**FE2**
Broker Fee	19.9427***	19.7750***
	(4.1354)	(4.1869)
Share of Brokers	6.9244***	6.9831***
	(0.8837)	(0.8967)
Coupon	2.1834**	2.5310***
	(0.8531)	(0.9307)
Risk (Fair Value)	-0.6954**	-0.6634*
	(0.3350)	(0.3725)
Continuous Observations	-1.4923***	-1.5047***
	(0.1297)	(0.1345)
Issuer Fixed Effects	X	X
Equity Fixed Effects		X
Observations	2542	2542
R-squared	0.4369	0.4410

Note: Bond size is measured in USD 1,000. Robust standard errors are reported in parentheses. ** and *** indicate significance at the 5% and 1% levels, respectively.

Table 2.6: Share of Brokers and Bond Size

	Coupon		Broker Fee		Issuer Markup	
	FE1	**FE2**	**FE1**	**FE2**	**FE1**	**FE2**
Share of Brokers	-0.1277***	-0.1080***	-0.0030	-0.0024	0.1308***	0.1105***
	(0.0205)	(0.0192)	(0.0022)	(0.0023)	(0.0208)	(0.0195)
Risk (Fair Value)	0.1448***	0.1171***	-0.0000	-0.0019	0.8551***	0.8848
	(0.0105)	(0.0101)	(0.0021)	(0.0023)	(0.0108)	(0.0104)
Continuous Observations	0.0040**	0.0063***	0.0090***	0.0092***	-0.0131***	-0.0156***
	(0.0018)	(0.0018)	(0.0005)	(0.0005)	(0.0020)	(0.0020)
Issuer Fixed Effects	X	X	X	X	X	X
Equity Fixed Effects		X		X		X
Observations	2542	2542	2542	2542	2542	2542
R-squared	0.1651	0.2381	0.3368	0.3439	0.8503	0.8629

Note: Bond size is measured in USD 1,000. Robust standard errors are reported in parentheses. ** and *** indicate significance at the 5% and 1% levels, respectively.

Table 2.7: Share of Brokers and Coupon/Broker Fee/Issuer Markup

Chapter 3

Financial Intermediaries and Agency Problems With and Without Vertical Incentives

3.1 Introduction

3.1.1 Research Question

In the previous chapter, I show some descriptive evidence of agency problems and vertical incentives in the U.S. reverse convertible bond market. Although the evidence suggests there are agency problems and vertical incentives, it is difficult to estimate the degree of agency problems and the degree of vertical incentives using a reduced-form analysis only. For instance, the results in Table 2.5 show that when a broker fee increases by 1 percentage point, there is a 15% increase in a bond sales on average. We may claim that agency problems are more severe if there were a 20% increase in a bond sales instead of a 15% increase but it is hard to interpret the number 15% itself. Similarly, the results in Table 2.6 show that when the share of brokers increases by 1 percentage point, there is a 7% increase in bond sales. A 7% increase in a bond sales suggests that there are vertical relationships between upstream and downstream firms but it is hard to understand the degree of vertical incentives. Does 7% mean that there are full vertical incentives or little vertical incentives? Furthermore, while it is necessary to empirically assess the welfare effects of agency problems and vertical incentives separately in order to fully understand their economic impacts, it is hard to disentangle the effects of these two forces using a reduced-form analysis. Thus this makes it difficult to run counterfactuals in which we investigate the welfare effects of agency problems when holding the degree of vertical incentives fixed and the welfare effects of vertical incentives when holding the degree of agency problems fixed. With this motivation, I now introduce a structural model in order to make the numbers in the second chapter more meaningful and more interpretable. In this chapter, I present a structural model of the U.S. reverse convertible bond market that allows us not only to test but also to quantify the degree of agency problems and the degree of vertical incentives separately. It will also enable me to evaluate the welfare effects of agency problems and vertical incentives on consumer surplus.

In order to do this, I develop and estimate a model that measures the degree of conflict of interest. I derive the market equilibrium where brokers offer a bond and investors make a discrete choice to buy or not to buy a bond. Using variation in broker fees, we get an estimate of the extent of the issue in this market, and the results suggest that there is a severe conflict of interest in this market. While brokers do consider the profits of their investors when offering bonds, I estimate that their own profits are roughly three times more important to them than the profits of their investors, suggesting the existence of severe agency problems that reduce consumer welfare considerably. I also include vertical incentives into a structural model and estimate the degree of vertical incentives using variation in the number of brokers at each downstream broker firm. My structural estimates show that brokers are willing to give up 1 dollar of their profit if their vertically integrated issuer's profit increases by 1.24 dollars.

Counterfactual analysis illustrates the welfare effects of agency problems and vertical incentives. Holding the degree of vertical incentives fixed, the welfare effects of agency problems are estimated to be -11.68%. When even more severe agency problems are considered, the welfare loss could be an additional 31.85%. At the current level of agency problems, the welfare effects of vertical incentives is estimated to be -2.31%. When brokers and their upstream firms are fully integrated, the welfare effects of vertical incentives could cause an additional consumer loss of 0.34%. In sum, counterfactual analysis shows that both agency problems and vertical incentives reduce consumer surplus but the welfare effects of agency problems are larger than those of vertical incentives.

3.1.2 Contributions to the Literature

This chapter contributes mainly to two strands of literature. To begin with, it complements existing approaches to analyzing agency problems in financial markets by estimating the degree of agency problems and vertical incentives. Using a search model, Egan (2019) studies how brokers distort retail customer investment decisions in the reverse convertible bond market. This is the most closely related paper since it also analyzes the reverse convertible bond market. However, this paper differs from Egan (2019) in two ways. First, I ask whether brokers care more about their investors or themselves. After providing some evidence that agency problems exist, Egan (2019) models a broker as an economic agent whose only goal is to maximize broker commission. In other words, Egan (2019) *assumes* that there are agency problems instead of measuring them. In this paper, however, I introduce a flexible broker objective function and measure the extent to which broker activity exhibits agency problems. The second contribution relative to Egan (2019) is that I try to answer the question of whether brokers place greater emphasis on selling their parent firm-issued products. Due to data limitations, Egan (2019) assumes that there is no difference in broker activities when they sell their parent firm-issued products versus when they sell their competitor firm-issued products. In contrast, by combining two different data sets, this chapter overcomes the data limitations and shows that brokers behave differently when they sell their vertically integrated upstream firm-issued products compared to when they sell products issued by vertically non-integrated upstream competitor firms. In doing so, I add a vertical integration structure to agency problems. In my counterfactual, I also investigate whether agency problems are exacerbated or mitigated by vertical relationships. In addition to Egan (2019), Robles-Garcia (2019) analyzes the effects of regulations restricting broker compensation when agency problems are present in the U.K. mortgage market. It also tries to estimate the magnitude of agency problems. Jiang, Nelson, and Vytlacil (2014) study the role of mortgage brokers in mortgage delinquency in the U.S. mortgage market. Finally, Anagol, Cole, and Sarkar (2017) show that agents overwhelmingly recommend unsuitable, strictly dominated products that provide high commissions to the agent in the Indian life insurance market.

This chapter also contributes to the literature by presenting a new model of agency problems. Agency problems are analyzed not only in financial markets but also in other markets. Among them, Iizuka (2007) is related to this chapter in the sense that it also measures the severity of agency problems. However, the model in this chapter differs from his model, as this chapter models a financial market while Iizuka (2007) models a prescription drug market. For example, Iizuka (2007) describes a doctor and patient pair as one economic agent since most patients passively follow the doctor's recommendation of drugs in practice. In contrast, in the model considered in this chapter, the broker and investor are modeled as two separate economic agents because an investor does not necessarily always follow the broker's recommendation of bonds. In other words, in Iizuka's (2007) model, a patient always takes a drug that a doctor recommends, but in the model presented in this paper, an investor has an option not to buy a bond that is offered by a broker. A broker, knowing that an investor has an outside option, tries to offer a bond which an investor would purchase. This restricts the set of bonds a broker will offer. In addition to Iizuka (2007), Iizuka (2012) and Ho and Pakes (2014) show that doctors are sensitive to their own financial incentives when dispensing drugs in the prescription drug market. In the real estate market, Levitt and Syverson

(2008) show that real estate agents behave differently when they are selling their own houses compared to when they are selling their clients' houses.

The remainder of the chapter is organized as follows. Section 2 describes the data. In Section 3, I develop an empirical model for the reverse convertible bond market. In Section 4, I discuss the identification of key parameters and introduce instruments. In Section 5, I discuss estimation and Section 6 performs counterfactual and welfare analyses. Section 7 concludes the chapter.

3.2 Data

Two data sets used in this chapter are described in the first chapter.

3.3 Model

In this section, I first present a structural model of the reverse convertible bonds market. Then, I discuss the model extension.

3.3.1 Model

Imagine a broker working for a broker firm b with an investor i. Investor i is captive to the broker. The key feature of the demand model is that investor i does not observe all the available products. A broker (he) provides a take-it-or-leave-it offer to show only one bond to an investor i (she), and she decides to buy it or not. If she purchases the bond, she receives a utility of u_{ij}

$$u_{ij} = \underbrace{\alpha \cdot c_j + \beta \cdot v_j + \xi_j}_{\delta_j} + \epsilon_{ij}, \;\; \epsilon_{ij} \sim \text{i.i.d.}\, F_\epsilon \, (\text{T1EV}) \tag{3.1}$$

where c_j is a coupon of bond j, α is a coupon coefficient, v_j is a risk (fair value) of bond j, β is a risk (fair value) coefficient, and ξ_j is an unobserved product characteristic. The random variable ϵ_{ij} is investor i's taste shock specific to product j, which is independently and identically distributed across investors and bonds and follows a type I extreme value distribution. δ_j is the common utility for product j shared by all investors. If she does not purchase, she receives a reservation utility $u_{i0} = \epsilon_{i0}$. So, investor i buys bond j if and only if $u_{ij} \geq \epsilon_{i0}$.

Next, I introduce a flexible broker objective function, which is a function of the issuer markup, broker fees, and investor utility. Formally, a broker at broker firm b maximizes his profit π_{ijb} by selling bond j to investor i

$$\pi_{ijb} = \begin{cases} \lambda \cdot \tau_{jb} + (1-\lambda) \cdot u_{ij} & \text{if investor } i \text{ buys} \quad (u_{ij} \geq \epsilon_{i0}) \\ 0 & \text{if investor } i \text{ does not buy} \quad (u_{ij} < \epsilon_{i0}) \end{cases}$$

$$\tau_{jb} = \kappa_j + \mu_b \cdot I_{fb} \cdot \eta_j \tag{3.2}$$

where τ_{jb} is a seller incentive of a broker at broker firm b for bond j, $\lambda \in [0,1]$ is the extent to which a broker values his seller incentives versus the utility of the investor, κ_j is a broker fee for bond j, and η_j is an issuer markup for bond j. The weight $\mu_b \in [0,1]$ is the extent to which a broker firm internalizes its integrated issuer profits and I_{fb} is a dummy variable indicating whether or not issuer f and broker firm b are vertically integrated. A broker considers the issuer's markup if they are vertically integrated ($I_{fb} = 1$) but discounts it with μ_b, i.e., μ_b is allowed to be strictly less than 1 (Crawford, Lee, Yurukoglu and Whinston; 2018).

To illustrate, a simple example of seller incentive is presented in Figure 3.1 and Table 3.1. Imagine a UBS issuer issues a UBS bond and a JP Morgan issuer issues a JP Morgan bond, and they both sell it through a UBS broker firm at the downstream market. Both the UBS bond and the JP Morgan bond have 5% issuer markups and 2% broker fees. Now we calculate seller incentives of the UBS broker firm for the UBS bond and for the JP Morgan bond. Assuming $\mu_b = 0.5$, the UBS broker firm's seller incentive for the UBS bond is $4.5\% = 2\% + 0.5 \cdot 1 \cdot 5\%$, as the UBS issuer and UBS broker firm are vertically integrated. For the JP Morgan bond, it is $2\% = 2\% + 0.5 \cdot 0 \cdot 5\%$, as the JP Morgan issuer and UBS broker firm are not vertically integrated. Thus, I allow the UBS broker firm to favor the bond issued by the UBS issuer over the bond issued by the JP Morgan issuer, depending on the value of μ_b.

The information sets of brokers and investors in this model are summarized in Table 3.2. Product characteristics such as the bond's coupon (c_j), risk (v_j), broker fee (κ_j), issuer markup (η_j) are observed by investors, brokers and the econometrician. Unobserved product characteristics (ξ_j) and investors' idiosyncratic demand shocks for each bond (ϵ_{ij}) are observed by investors and brokers while they are unobserved by an econometrician. This means that I assume that a broker observes ϵ_{ij}, which means that a broker knows his investor's type. This is rationalized by two facts. One is that there are repeated long-term interactions between brokers and investors and the other is that brokers observes investors' past investment histories. Assume a broker does not offer bond j if an investor would not buy it. So a broker offers bond j only if $u_{ij} \geq \epsilon_{i0}$. Then we can define a feasible set as follows.

$$F_{ij} = \{\, j \,|\, u_{ij} \geq \epsilon_{i0} \,\} \tag{3.3}$$

A feasible set F_{ij} consists of bond j that investor i would buy if offered by a broker. Then we can define ϕ_{ijb} as broker's probability to offer bond j to investor i

$$\phi_{ijb} = \begin{cases} 0 & \text{if } \exists k \in F_{ij} \text{ and } \lambda\tau_{jb} + (1-\lambda)u_{ij} < \lambda\tau_{kb} + (1-\lambda)u_{ik} \\ 1 & \text{if } \lambda\tau_{jb} + (1-\lambda)u_{ij} \geq \lambda\tau_{kb} + (1-\lambda)u_{ik}, \;\; \forall k \in F_{ij} \end{cases}$$

Lastly, we can compute the market share of bond j within a broker.

$$s_{jb} = \int_{\epsilon_i} \phi_{ijb} \cdot 1 \, dF_{\epsilon}^{J+1} \tag{3.4}$$

where $\epsilon_i = (\epsilon_{i0}, \epsilon_{i1}, \epsilon_{i2}, ..., \epsilon_{iJ})$, F_{ϵ}^{J+1}: a distribution of ϵ_i.

In Table 3.3, the interpretation of λ and μ_b is summarized. When $\lambda = 0$, a broker maximizes the investor's utility only, so there is no agency problem. When $\lambda = 1$, a broker maximizes his own seller incentive only, so there is a complete agency problem. When $0 < \lambda < 1$, a broker not only maximizes investor utility but also maximizes his own seller incentive. Likewise, $\mu_b = 0$ represents a lack of vertical incentives, which means a downstream broker does not care about its vertically integrated upstream issuer. When $\mu_b = 1$, this means full vertical incentives. When $0 < \mu_b < 1$, a downstream broker cares about its upstream issuer but not fully. This may indicate intra-firm frictions or divisionalization.

Comparing the model in this paper with the literature, Egan (2019) also analyzes the reverse convertible bond market. However, this paper differs from his paper in terms of a broker objective function. While Egan (2019) assumes that a broker maximizes broker fees only, I introduce a flexible broker objective function and allow a broker to maximize issuer markup, broker fee, and investor utility. If I were to explain his model using the model set up considered in this paper, Egan (2019) assumes that $\lambda = 1$ and $\mu_b = 0$ while λ and μ_b are parameters to be estimated in this paper. Thus the model in this paper is more general than his model in terms of a broker objective function. [1] When I introduce a flexible broker objective function, I assume that a broker observes ϵ_{ij}, which means that a broker knows his investor's type. This is rationalized by two specific features in this market. One is that there are usually long-term and repeated interactions between brokers and investors, and the other is that brokers observe their investors' past investment histories. If an investor has purchased many dominated bonds in the past, it is likely

[1] On the other hand, Egan (2019) introduces a consumer search which is not considered in the model of this paper.

that she would purchase another dominated bond again.

In order to characterize the equilibrium, I show a simple example of two bonds. Assume $0 \leq \lambda < 1$. [2] Without loss of generality, $\tau_{1b} \leq \tau_{2b}$, so Bond 2 provides a higher or equal seller incentive than Bond 1 does. Then, a broker equilibrium strategy is summarized in Table 3.4. The first row shows a case where selling Bond 1 is less profitable than selling Bond 2 from a broker's perspective. The second row is a case in which selling Bond 1 is more or equally profitable than selling Bond 2 from a broker's perspective. Each column shows an investor's preferences. The first column shows a case when an investor prefers Bond 1 over an outside option and also prefers Bond 2 over an outside option. The second column is a case where an investor prefers an outside option over Bond 1 and also prefers Bond 2 over an outside option. In the third column, an investor prefers Bond 1 followed by an outside option and least prefers Bond 2. In the last column, an investor prefers an outside option most. Now we investigate what happens in equilibrium in each case. In the last column, an investor does not purchase Bond 1 or Bond 2 when offered. Knowing this, a broker does not offer a bond. The third column shows a case where $u_{i1} \geq u_{i0}$ & $u_{i2} < u_{i0}$. If a broker offers Bond 1, an investor will buy it while an investor would not buy Bond 2 when offered. Hence, the broker has no choice but to offer Bond 1. Similarly, in the second column, an investor would purchase Bond 2 when offered but would not purchase Bond

[2] For simplicity, I exclude $\lambda = 1$ but all results are valid when $\lambda = 1$. For instance, s_{jb} when $\lambda = 1$ can be computed by $\lim_{\lambda \to 1} s_{jb}$. As adjustment terms involve exponential functions only, $\lambda = 1$ is not a degenerate case.

1 when offered. Knowing this, a broker would offer Bond 2 and an investor would accept it. A more interesting case is shown in the first column, where $u_{i1} \geq u_{i0}$ & $u_{i2} \geq u_{i0}$. In this case, a broker offers Bond 1 if it gives higher profit to him and offers Bond 2 otherwise. This is where λ plays its role. The key feature is that the broker offers Bond 1 or 2, which maximizes his own profit rather than maximizing the investor's profit (i.e., this is where the distortion comes in). Assuming that ϵ_{ij} follows an i.i.d. type I extreme value distribution, the market share equations have the following analytical forms, [3]

$$s_{1b} = \frac{e^{\delta_1}}{e^{\delta_2} + e^{\delta_1} + 1} \cdot a_{12b}(\lambda), \tag{3.5}$$

$$s_{2b} = \frac{e^{\delta_2}}{e^{\delta_2} + e^{\delta_1} + 1} \cdot a_{22b}(\lambda), \tag{3.6}$$

$$s_{0b} = \frac{1}{e^{\delta_2} + e^{\delta_1} + 1}, \tag{3.7}$$

where adjustment terms a_{12b} and a_{22b} are presented in Table 3.5. The first row shows an adjustment term for Bond 1 when a broker at broker firm b sells Bond 1 and Bond 2. The second row shows an adjustment term for Bond 2 when a broker at broker firm b sells Bond 1 and Bond 2. Note that $\tau_{1b} \leq \tau_{2b}$. For the market share of Bond 1, the logit market share is multiplied by an adjustment term. When $\lambda = 0$, the adjustment term becomes 1, and the model becomes nothing but a standard logit model (Berry 1994). When $\tau_{1b} < \tau_{2b}$, meaning Bond 2 has a strictly higher seller incentive than Bond 1,

[3]See the appendix for market shares derivation.

then the adjustment term $a_{12b}(\lambda)$ is a strictly decreasing function of λ while the adjustment term $a_{22b}(\lambda)$ is a strictly increasing function of λ. Thus, adjustment terms measure the degree of distortion induced by agency problems. It is straightforward to calculate the general form of market share equations.

$$s_{jb\,(1\leq j\leq n)} = \frac{e^{\delta_j}}{1+\sum_{k=1}^{n} e^{\delta_k}} \cdot a_{jnb}(\lambda), \tag{3.8}$$

$$s_{0b} = \frac{1}{1+\sum_{k=1}^{n} e^{\delta_k}}, \tag{3.9}$$

where an adjustment term a_{jnb} is presented in Table 3.6. a_{jnb} denotes an adjustment term for jth bond when a broker at broker firm b offers n different bonds. Note that each bond is ordered in the increasing order of a broker's seller incentives, $\tau_{1b} \leq \tau_{2b} \leq ... \leq \tau_{jb} ... \leq \tau_{n-1,b} \leq \tau_{nb}$. Thus brokers at different broker firms may have different orders of bonds depending on their vertical relationships even though all brokers are offering the same set of bonds. Now we have computed market shares within a broker firm, but the data is such that we do not observe market shares within a broker firm. We now aggregate them across broker firms. Based on the second data set on a shares of brokers by firm, we aggregate market shares within a broker firm using each firm's share of brokers as weights.

$$s_{j\,(1\leq j\leq n)} = \sum_{b} \rho_b \cdot s_{jb}, \tag{3.10}$$

$$s_0 = \sum_b \rho_b \cdot s_{0b}, \tag{3.11}$$

where ρ_b denotes $\frac{\text{the number of brokers employed by broker firm } b}{\text{total number of brokers in the market}}$. The idea is that if the UBS broker firm has more brokers, then there is more weight on their market shares compared to other broker firms. An implicit assumption used here is that investment funds managed by each broker firm are proportional to a number of brokers employed by each broker firm. One might expect that a more experienced broker will deal with more investment funds compared to an inexperienced broker. But this argument is strongest for comparisons within a broker firm, not across broker firms. Unless one broker firm has proportionally more experienced brokers than another broker firm has, this assumption is not harmful.

3.3.2 Model Extension: Nested Logit

I assume the simple logit utility function in the basic model, where ϵ_{ij}'s are independently and identically drawn from a type I extreme value distribution. This can be a strong distributional assumption, as in reality an investor i with a high ϵ_{ij} for bond j may be more likely to have a high $\epsilon_{ij'}$ for bond j'. To accommodate this, I extend the utility function to the nested logit case. [4] Investor tastes still follow a type I extreme value distribution, but the nested logit model allows investor tastes to be correlated across bonds. This allows for more reasonable substitution patterns compared to the simple logit

[4] Note that all identification results discussed in later section are valid when we extend the model to the nested logit case.

model. First, I group the bonds into two exhaustive and mutually exclusive sets, $g = 0, 1$. $g = 0$ indicates an outside good while $g = 1$ denotes inside goods in the market. The outside option, $j = 0$, is assumed to be the only member of group $g = 0$, and for each bond j in group $g = 1$, the utility of investor i is

$$u_{ij} = \underbrace{\alpha \cdot c_j + \beta \cdot v_j + \xi_j}_{\delta_j} + \zeta_{ig} + (1-\sigma)\epsilon_{ij}, \ \ \epsilon_{ij} \sim \text{i.i.d.}\, F_\epsilon \,(\text{T1EV}), \tag{3.12}$$

where σ is a nesting parameter. For investor i, the variable ζ_{ig} is common to all bonds in $g = 1$ and has a distribution function that depends on a nesting parameter σ, with $0 \leq \sigma < 1$. As the nesting parameter σ approaches one, the within-group correlation goes to one, and as σ approaches zero, the within-group correlation goes to zero as in the simple logit model.

3.4 Identification and Instruments

I discuss the identification of key parameters, λ and μ_b, in this section. Then I introduce instruments to address the endogeneity issue.

3.4.1 Identification of λ

Now I discuss the source of identification for key parameters of the model, starting with λ. Consider a simple two bond example, where $\mu_b = 0$ in Figure 3.2. An issuer issues two bonds, Bond 1 and Bond 2, and sells them through a broker firm. Bond 1 and 2 have the same common utility of 0, but a broker fee for Bond 1 is 2% and a broker fee for Bond 2 is 3%, as shown in Table 3.7. By assuming $\mu_b = 0$, the seller incentive for Bond 1 will be 2% and that for Bond 2 will be 3%, so a broker firm has more incentive to sell Bond 2 compared to Bond 1. In this setting, the model-predicted market shares are presented in Table 3.8. When $\lambda = 0$, a broker maximizes investor utility only, and two bonds and an outside option have the same common utility of 0; hence, all market shares are the same (0.33). When $\lambda = 1$, a broker only cares about seller incentives (which are equal to broker fees since $\mu_b = 0$). This means a broker will try to sell Bond 2 as much as he can since it pays a higher broker fee than Bond 1 does. However, a broker cannot always force an investor to buy Bond 2 because of her reservation utility. So, as long as an investor's utility from Bond 2 is greater than or equal to a reservation utility, a broker will offer and sell Bond 2. Since Bond 2 and an outside option are equally attractive to investors, the probability that an investor's utility from Bond 2 will be greater than that of the outside option is 0.50. Concerning Bond 1, it is still profitable for a broker to sell it to earn the 2% broker fee if he cannot sell Bond 2 since a broker earns nothing when an investor chooses an outside option. This is the case where an investor values Bond 1 most, the outside option next and Bond 2 the least. As there are three products that are equally attractive to investors, the probability of this particular order is 1/6 or 0.17. For Bond 1, which has a lower broker fee, the market share when $\lambda = 0.5$ is lower than the market share when $\lambda = 0$ but higher than the market share when $\lambda = 1$. In contrast, for Bond 2, which has a higher broker fee, the market share when $\lambda = 0.5$ is higher than the market share when $\lambda = 0$ but lower than the market share when $\lambda = 1$. What we learn from this exercise is that for Bond 1 with a lower broker fee, its market shares decrease when λ increases. For Bond 2 with a higher broker fee, its market shares increase when λ increases. This example shows that variation in broker fees identifies λ. In other words, the extent to which broker fees affect market shares will identify λ. As broker fees are endogenously chosen by upstream issuers, I use instruments to address the issue of endogeneity.

3.4.2 Identification of μ_b

Next, I discuss the source of identification for μ_b. To illustrate, consider a simple example of two broker firms where $\lambda = \mu_b = 0.5$. As in Figure 3.3, imagine that the UBS issuer issues a UBS bond and sells it through the UBS broker firm and the JP Morgan broker firm. Likewise, the JP Morgan issuer issues a JP Morgan bond and also sells it through the UBS broker firm and the JP Morgan broker firm. As shown in Table 3.9, the UBS and JP Morgan bonds have the same product characteristics. Both bonds have 0 common utility, 2.0% broker fee and 5.0% issuer markup. However, the UBS broker firm and the JP Morgan broker firm have different seller incentives due to their vertical relationships. The UBS broker firm has a seller incentive of 4.5% [5] for the UBS bond and 2.0% [6] for the JP Morgan bond, arising from their

[5] 4.5% = 2.0% + 0.5 * 1 * 5.0%
[6] 2.0% = 2.0% + 0.5 * 0 * 5.0%

vertical relationship. It is symmetric in the JP Morgan broker firm's case. What is not symmetric is the number of brokers employed by each broker firm. As illustrated in Table 3.10, the UBS broker firm has 60 brokers while the JP Morgan broker firm has 40 brokers in Market 1. In Market 2, the UBS broker firm has even more brokers, 80, and the JP Morgan broker firm has only 20.

With the assumption that each broker manages USD 1mm as a normalization, the market shares are presented in Table 3.11. The market size is USD 100mm, as there are 100 brokers in each market. In Market 1, the market size USD 100mm is split into USD 60mm and USD 40mm according to the number of brokers in each broker firm. Within a broker firm, market shares are computed according to Equation (3.8). For a UBS broker firm, the market share of a UBS bond is 0.48 so a bond size is 28.8mm and the market share of a JP Morgan bond is 0.19 so a bond size is 11.4mm. For a JP Morgan broker firm, the market share of a UBS bond is 0.19 so a bond size is 7.6mm and the market share of a JP Morgan bond is 0.48 so a bond size is 19.2mm. At the market level, the total size of a UBS bond is 36.4mm [7] and the total size of a JP Morgan bond is 30.6mm. [8] As can be expected, within a broker firm, market shares are symmetric in the UBS broker firm and the JP Morgan broker firm, but overall, the UBS bond has more market share (36.4%) than the JP Morgan bond has (30.6%) since the UBS bond is favored by the UBS

[7] 36.4=28.8+7.6.

[8] 30.6=11.4+19.2.

broker firm, which has more brokers than the JP Morgan broker firm has. In Market 2, the market size USD 100mm is split into USD 80mm and USD 20mm according to the number of brokers in each broker firm. There are no changes in seller incentives between Market 1 and Market 2 but the number of brokers changes. For a UBS broker firm, the market share of a UBS bond is still 0.48 as its seller incentives do not change. Given that it has the market size of 80mm, the bond size now becomes 38.4mm. The market share of a JP Morgan bond is 0.19 so the bond size is 15.2mm. For a JP Morgan broker firm, the market share of a UBS bond is still 0.19 but now the bond size becomes only 3.8mm as it loses its brokers. The market share of a JP Morgan bond is 0.48 and the bond size is 9.6mm. At the market level, the total size of a UBS bond is 42.2mm [9] and the total size of a JP Morgan bond is 24.8mm. [10] Compared to Market 1, in Market 2, the UBS bond gains even more market share (42.2%) as the number of brokers in the UBS broker firm increases. This simple example illustrates the identification of μ_b. The extent to which the number of vertically integrated brokers affects market shares will identify μ_b. If μ_b =0, the market share of the UBS bond will be the same in Markets 1 and 2. If μ_b is high, then the market share of the UBS bond in Market 2 will increase more compared to the market share of the UBS bond in Market 1. Thus, exogenous time variation in the share of brokers at each broker firm ρ_b identifies μ_b. Cross-sectional variation in the share of brokers could also be

[9] 42.2=38.4+3.8.
[10] 24.8=15.2+9.6.

used in identifying μ_b. However, as I add issuer fixed effects in the structural estimation, I rely on time variation rather than cross-sectional variation of the share of brokers.

3.4.3 Instruments

If issuers choose coupons and broker fees considering product characteristics of bonds unobserved by the econometrician, then these two price variables are endogenous as they are potentially correlated with unobserved characteristics. To resolve this endogeneity issue, I use differentiation IVs as suggested by Gandhi and Houde (2017). Three instruments measure the degree of differentiation in the product space.

The first instrument, which I denote by $Z1$, measures the Euclidean distance between the product and the issuer's competitors' products in terms of risk (fair value).

$$Z_{j1} = \sqrt{\sum_{j' \notin \mathcal{F}_f} (v_{j'} - v_j)^2} \tag{3.13}$$

The second instrument, denoted by $Z2$, measures the Euclidean distance between the product and other products issued by the same issuer in terms of risk (fair value).

$$Z_{j2} = \sqrt{\sum_{j' \in \mathcal{F}_f} (v_{j'} - v_j)^2} \tag{3.14}$$

The last instrument, denoted by $Z3$, measures the number of products with the same underlying asset in the market. For instance, if a bond is linked to the Apple stock price, the third instrument shows how many Apple-linked bonds are offered in the market. The basic idea is that the first two instruments measure the degree of differentiation in terms of risks (fair values) while the last instrument measures the degree of differentiation in terms of underlying assets. The latter will affect how issuers set prices whether or not investors have a close substitute.

To illustrate, a simple example is presented in Table 3.12. Issuer 1 issues Bond 1 and Bond 2 while Issuer 2 issues Bond 3 and Bond 4. Bond 1 has a risk of 15 and is linked to an Apple stock price. Bond 2 has a risk of 17 and is also linked to an Apple stock price. Bond 3 has a risk of 14 and is also linked to an Apple stock price. Bond 4 has a risk of 16 and is linked to an IBM stock price. Now we calculate instruments for Bond 1. For Bond 1, the first instrument measures the distance between Bond 1 and Bond 3/Bond 4 so $z_{j=1,1} = \sqrt{2}$. [11] The second instrument measures the distance between Bond 1 and Bond 2 so $z_{j=1,2} = 2$. [12] The last instrument measures the number of products with the same underlying asset in the market so it is 3.

[11] $\sqrt{2} = \sqrt{(14-15)^2 + (16-15)^2}$
[12] $2 = \sqrt{(17-15)^2}$

3.5 Estimation

In this section, I first explain the estimation strategy to recover structural parameters. Then I discuss the estimation results. I also make a policy recommendation.

3.5.1 Estimation Strategy

The estimation strategy involves three steps. In Step 1, given any $\mu_b \in [0,1]$, $\lambda \in [0,1)$, and $\sigma \in [0,1)$, we find δ_j using a contraction mapping. [13] [14]

Step 2 is an instrumental variables regression to back out $\hat{\xi}(\mu_b, \lambda, \sigma)$ using the following assumption.

$$\mathrm{E}[\,\xi(\mu_b, \lambda, \sigma)\,|\, z_1, v\,] = 0. \tag{3.15}$$

In Step 3, I construct a GMM objective function for the demand side. [15] I consider the following moment condition.

$$\text{Moment:}\;\; \mathrm{E}[\,\xi(\mu_b, \lambda, \sigma)\,|\,(\sum_b I_{fb} \cdot \rho_b) \cdot \eta,\; z_2,\; z_3\,] = 0. \tag{3.16}$$

[13] Note that compared to Berry, Levinsohn and Pakes (1995), we apply the modified contraction mapping as we allow for a nesting parameter σ in the investor utility function, i.e. $f_j(\delta) = \delta_j + (1-\sigma)\{\log(s_j) - \log(s_j(\delta))\}$. For detailed explanation, see Grigolon and Verboven (2014).

[14] Alternatively, we can use Berry inversion if s_{jb} data is available.

[15] In particular, I use a continuous-updating GMM.

Based on this conditional moment condition, I construct a set of unconditional moment conditions and estimate μ_b, λ, and σ by GMM.

3.5.2 Estimation Results

The main estimation results are presented in Table 3.13 for a simple logit model and Table 3.14 for a nested logit model. In each table, the first column shows the estimation results when we assume that coupons and broker fees are exogenous. The second column shows the estimation results when we instrument for coupons and broker fees. All specifications include both issuer fixed effects and equity fixed effects. In the simple logit case, the λ estimate in the first row is 0.5753 under an exogenous price assumption while it is 0.4666 under an endogenous price assumption. The λ estimate being bigger than 0 while being smaller than 1 indicates that brokers not only care about their own financial incentives but they also care about their investors. The μ_b estimate in the second row is 0.2775 under an exogenous price assumption while it is 0.1821 under an endogenous price assumption. The μ_b estimate being bigger than 0 means brokers care about their vertically integrated issuer's profits while being smaller than 1 means brokers and issuers are not fully integrated. The α estimate in the third row is 0.0142 under an exogenous price assumption while it is 0.0860 under an endogenous price assumption. As we can expect, investors prefer higher coupons holding others fixed. The β estimate in the fourth row is -0.0046 under an exogenous price assumption while it is -0.0129 under an endogenous price assumption. As one can expect, investors prefer less risk holding others fixed.

In the nested logit case, the estimate of λ in the first row is 0.3157 under an exogenous price assumption while it is 0.4984 under an endogenous price assumption. Again, the estimated λ is bigger than 0 and smaller than 1 which indicates that brokers care about both their own incentives and investor utilities. The μ_b estimate in the second row is 0.6475 under an exogenous price assumption while it is 0.8017 under an endogenous price assumption. Similarly with the results from the previous table, the μ_b estimate is bigger than 0 and smaller 1 which suggests partial vertical incentives. The α estimate in the third row is 0.0140 under an exogenous price assumption while it is 0.3300 under an endogenous price assumption. The positive signs of the estimates show that investors prefer higher coupons holding everything else fixed. The β estimate in the fourth row is -0.0269 under an exogenous price assumption while it is -0.0926 under an endogenous price assumption. The negative signs of the estimates show that investors prefer less risk holding others fixed. The nesting parameter σ estimate in the fifth row is 0.5927 under an exogenous price assumption and it is 0.7844 under an endogenous price assumption. A higher value of nesting parameter estimate means investor's idiosyncratic demand shocks for reverse convertible bonds are positively correlated. This is expected because if an investor has a positive demand shock for one reverse convertible bond, then it is more likely that she has a positive demand shock for another reverse convertible bond as well. Among four specifications, the last column in Table 3.14 is the most preferred specification, where we instrument for potential endogeneity, add both fixed effects and allow correlation between idiosyncratic errors. Recall that under the fiduciary duty requirement, λ needs to be close to 0, as brokers are expected to maximize investor utility. However, λ is estimated to be 0.4984. Also, in an arms-length transaction, μ_b needs to be close to 0, but it is estimated to be 0.8017.

$$\begin{aligned} \pi_{ijb} &= \lambda \cdot (\kappa_j + \mu_b \cdot I_{fb} \cdot \eta_j) + (1-\lambda) \cdot u_{ij} \\ &= \lambda \cdot (\kappa_j + \mu_b \cdot I_{fb} \cdot \eta_j) + (1-\lambda)\alpha \cdot \frac{u_{ij}}{\alpha} \end{aligned} \tag{3.17}$$

In order to interpret the results, we need to be particularly careful about the units. Broker fees and issuer markups in the first term on the right-hand side in the equation above are measured in U.S. dollars, but investor utility in the second term is not. So, we divide and multiply by the coupon coefficient α in order to express it in terms of U.S. dollars. Broker profit goes up by λ when a broker receives \$1, while broker profit goes up by $(1-\lambda)\alpha$ when an investor receives \$1. Thus, brokers are willing to give up 1 dollar of their own profit if their investor's profit goes up by 3.01 dollars. [16] In order to put this number into perspective, I compare the results with Iizuka (2007). He shows that physicians are willing to give up 1 dollar of their profit from markup if they can reduce the cost to the patient by 28 cents in the Japanese prescription drugs market. If I compare these two numbers only, it seems agency problems are more severe in the U.S. financial market than in the Japanese prescription

[16] $3.01 = \frac{0.4984}{(1-0.4984)\cdot 0.3300}$

drug market. Similarly, regarding vertical incentives, brokers are willing to give up 1 dollar of their profit if their vertically integrated issuer's profit goes up by 1.24 dollars. [17]

3.5.3 Discussion

In deriving the results, I use an implicit assumption that investment funds managed by each broker firm are proportional to the number of brokers employed by each broker firm. The reason I introduce this assumption is related to the current filing requirements. Under current Form 424B, each issuer is required by the SEC to report the size of bonds issued at the overall market level but not at a broker firm level. For instance, a UBS issuer is required to report the size of each bond issued across all broker firms, including UBS and JP Morgan broker firms, but not the breakdown of each broker firm, such as how much is sold through the UBS and JP Morgan broker firms. Thus, I introduce this assumption in order to recover the market shares within a broker firm. By adopting a stronger filing requirement, according to which all issuers are required to report how much bond size is sold by each broker firm, we will be able to accumulate more detailed data. With new data, I believe we will be able to obtain more precise estimates of the degree of agency problems and those of the degree of vertical incentives. Further, with new data, we will be able to answer other interesting questions, such as whether broker firms have different degrees of agency problems instead of assuming that all broker

[17] $1.24 = \frac{0.4984}{0.4984 \cdot 0.8017}$

firms have the same degree as in this paper.

3.6 Counterfactual Analysis

In this section, I first explain the assumptions needed for a counterfactual analysis. Then I discuss the counterfactual results.

3.6.1 Setting

In this section, I use the estimates from the main model to simulate counterfactual scenarios. First, I consider equilibrium effects from agency problems holding the degree of vertical incentives fixed. Second, I consider the welfare effects of vertical incentives between upstream issuers and downstream broker firms when holding the degree of agency problems fixed. In all simulations, I make assumptions used in a short-run analysis. The product space is fixed so that brokers do not change their available products and that there is no entry or exit in the market. Investor preferences remain unchanged.

I define the social surplus in the following ways. First, issuer profit is the sum of all issuer markups across all bonds.

$$\sum_j M \cdot s_j \cdot \eta_j, \tag{3.18}$$

where M is the total market size. Second, broker firm profit is the sum of all broker fees across all the bonds.

$$\sum_j M \cdot s_j \cdot \kappa_j \tag{3.19}$$

Finally, consumer surplus is the sum of all investor utilities across all the bonds divided by the coupon coefficient to convert to U.S. dollar terms.

$$\frac{1}{\alpha}\sum_b M \cdot \rho_b \Bigg[\sum_{j=1}^{n} \Big(\sum_{k=1}^{n} e^{\frac{\delta_k}{1-\sigma}}\Big)^{1-\sigma} \cdot \frac{e^{\frac{\delta_j}{1-\sigma}}}{\sum_{k=1}^{n} e^{\frac{\delta_k}{1-\sigma}}} \cdot \frac{\log\big(1 + (\sum_{k=1}^{n} e^{\frac{\delta_k - \frac{\lambda}{1-\lambda}(\tau_{jb}-\tau_{kb})}{1-\sigma}})^{1-\sigma}\big) + \gamma}{1 + (\sum_{k=1}^{n} e^{\frac{\delta_k - \frac{\lambda}{1-\lambda}(\tau_{jb}-\tau_{kb})}{1-\sigma}})^{1-\sigma}} + \frac{\log\big(1 + (\sum_{k=1}^{n} e^{\frac{\delta_k}{1-\sigma}})^{1-\sigma}\big) + \gamma}{1 + (\sum_{k=1}^{n} e^{\frac{\delta_k}{1-\sigma}})^{1-\sigma}} \Bigg], \tag{3.20}$$

where γ is the Euler-Mascheroni constant. [18] For each scenario, I assume that choices made by the upstream issuer are exogenous. Given the fixed product space, I run counterfactuals with new parameter values of λ and μ_b.

3.6.2 Counterfactual Results

The counterfactual analysis of consumer surplus is presented in Table 3.15. Each column corresponds to a different value of λ such as $\lambda = 0$, $\lambda = 0.49$, $\lambda = 0.70$. Similarly, each row corresponds to a different value of μ_b, such as $\mu_b = 0$, $\mu_b = 0.80$ and $\mu_b = 1$. The baseline is the case when $\lambda = 0.49$ and $\mu_b = 0.80$, which is based on the main estimation results, and

[18] $\gamma \approx 0.5772$

the consumer surplus at the baseline is \$17,109,000. In each cell or each counterfactual, there are two rows. The first row in each cell shows the absolute difference between the consumer surplus at this scenario and the consumer surplus at the baseline. For instance, under perfect regulation enforcement ($\lambda = 0$ and $\mu_b = 0$), consumer surplus increases by \$1,999,000 compared to the baseline, resulting in a total consumer surplus of \$19,108,000. [19] The second row in each cell shows the relative difference between the consumer surplus in this scenario and the consumer surplus at the baseline. For instance, under perfect regulation enforcement ($\lambda = 0$ and $\mu_b = 0$), consumer surplus is 11.68% larger than at the baseline estimates. [20] In the first column, the second row in each cell is all 11.68% since vertical incentives do not play a role when there are no agency problems, $\lambda = 0$. In the second column, the second row in each cell is 2.31%, 0.00%, -0.34% from top to bottom of the column. This shows the consumer welfare effects of vertical incentives while holding the degree of agency problems fixed. In the third column, the second row in each cell is -30.11%, -31.85%, -31.94% from top to bottom of the column. It indicates how vertical incentives affect consumer welfare when agency problems are very severe. In a similar fashion, when we compare different columns for the same row, we are able to investigate the welfare effects of agency problems while holding the degree of vertical incentives fixed.

The key message in the table is that the loss in the consumer surplus is

[19] 19,108,000=17,109,000+1,999,000.

[20] 11.68%=$\frac{19,108,000-17,109,000}{17,109,000}$.

11.68% compared to the case when $\lambda = 0$ and $\mu_b = 0.80$, which characterizes the size of agency costs. Although 11.68% is substantial, I believe agency costs of 11.68% are underestimated for two reasons. The first reason is that I fix the upstream issuer's side. When $\lambda = 0$, brokers behave differently but issuers do not change their price-settings in current counterfactuals, i.e. the product space is exogenously given. However, once issuers adjust their price-setting behaviors knowing that brokers now behave differently, the consumer surplus loss is expected to be greater than 11.68%. Secondly, the counterfactual exercise involves the substitution within inside goods only. In my counterfactual analysis, brokers offer other reverse convertible bonds when the structural parameters change. One may view a group of reverse convertible bonds as bad products. In this view, my counterfactual analysis can be seen as brokers offering less bad products rather than offering better products other than reverse convertible bonds. If the counterfactual analysis were to allow the substitution to other products, I believe agency costs would be higher than 11.68%.

When $\lambda = 0.70$, which means that there are more severe agency problems, consumer surplus decreases by an additional 31.85%. The change in consumer surplus is 11.68% when λ moves from 0 to 0.49, but when λ moves from 0.49 to 0.70, the change in consumer surplus is 31.85%, which seems large. The reason for this is that $\frac{\lambda}{(1-\lambda)\alpha}$ is a better measure than λ itself, as λ does not take units into account. When $\lambda = 0$, $\frac{\lambda}{(1-\lambda)\alpha} = 0$, which means a broker is not responsive to broker fees at all. When $\lambda = 0.49$, $\frac{\lambda}{(1-\lambda)\alpha} = 3.01$, which indicates that a broker values his own profit 3.01 times more than his investor's profit. Lastly, when $\lambda = 0.70$, $\frac{\lambda}{(1-\lambda)\alpha} = 7.07$, which indicates that a broker values his own profit 7.07 times more than his investor's profit. In addition, I find that the welfare effects of vertical incentives are negative, as consumer welfare is 2.31% lower compared to a counterfactual when $\lambda = 0.49$ and $\mu_b = 0$. When $\lambda = 0.49$ and $\mu_b = 1$, consumer welfare goes down by an additional 0.34%. The reason that the welfare effects of vertical incentives are negative is that there is no double marginalization in this market. Consequently, there is no gain in consumer surplus due to vertical incentives. In sum, both agency problems and vertical incentives reduce consumer welfare, although the magnitude is much larger for agency problems than for vertical incentives.

3.7 Concluding Remarks

This chapter investigates agency problems in the financial advising industry. In particular, I consider potential incentive problems between brokers and their investors. In doing so, this chapter contributes to the literature by estimating the severity of agency problems and the degree of vertical incentives in the U.S. reverse convertible bond market. The results suggest that while brokers do consider the profits of their investors, their own profits are roughly three times more important to them than the profits of their investors. I also show that brokers value their own profit 24% more than the profit accrued to their vertically integrated upstream firm. It also contributes to the literature by presenting a new agency model in which consumers have an outside option, which has not been allowed in previous agency models. Although the empirical model in this paper best describes the reverse convertible bond market, this framework can be used not only in other retail financial markets where brokers recommend financial products to their investors but also non-financial markets where experts offer products to their consumers. It will be interesting to compare the degree of agency problems in many markets using the unified framework suggested in this chapter.

Lastly, I move to a discussion of potential future extensions. In deriving my results, I assume that brokers know their clients (i.e., brokers observe investor types). While this can be justified by the fact that brokers and investors usually have long-term repetitive relationships, this may not be true. In my future work, it will be interesting to see whether or not brokers know their clients, and individual-level data on brokers and investors will be particularly useful in determining this. In addition, we could also consider a dynamic model. I use a static model to measure the degree of agency problems, but the λ estimate in this model may capture some of the dynamic aspects of broker-investor relationships. I leave these as future extensions.

	UBS Bond	**JP Morgan Bond**
Issuer Markup (η_j)	5%	5%
Broker Fee (κ_j)	2%	2%
Seller Incentive (τ_{jb})	$4.5\% = 2\% + 0.5 \cdot 1 \cdot 5\%$	$2\% = 2\% + 0.5 \cdot 0 \cdot 5\%$

Table 3.1: Seller Incentive Example

	Investor	**Broker**	**Econometrician**
c_j, v_j, κ_j, η_j	Observable	Observable	Observable
ξ_j, ϵ_{ij}	Observable	Observable	Unobservable

Table 3.2: Information Structure

λ	**Interpretation**	μ_b	**Interpretation**
$\lambda = 0$	No agency problem	$\mu_b = 0$	No vertical incentives
$0 < \lambda < 1$	Partial agency problem	$0 < \mu_b < 1$	Partial vertical incentives
$\lambda = 1$	Complete agency problem	$\mu_b = 1$	Full vertical incentives

Table 3.3: Interpretation of λ and μ_b

	$u_{i1} \geq u_{i0}$ & $u_{i2} \geq u_{i0}$	$u_{i1} < u_{i0}$ & $u_{i2} \geq u_{i0}$	$u_{i1} \geq u_{i0}$ & $u_{i2} < u_{i0}$	$u_{i1} < u_{i0}$ & $u_{i2} < u_{i0}$
$\lambda\tau_{1b} + (1-\lambda)u_{i1} < \lambda\tau_{2b} + (1-\lambda)u_{i2}$	Bond 2	Bond 2	Bond 1	No bond offer
$\lambda\tau_{1b} + (1-\lambda)u_{i1} \geq \lambda\tau_{2b} + (1-\lambda)u_{i2}$	Bond 1	Bond 2	Bond 1	No bond offer

Table 3.4: Two Bonds Example Equilibrium

$a_{12b}(\lambda)$	$\frac{e^{\delta_2 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})} + e^{\delta_1 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})} + 1}{e^{\delta_2} + e^{\delta_1 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})} + 1}$
$a_{22b}(\lambda)$	$\frac{e^{\delta_2 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{2b})} + e^{\delta_1 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{2b})} + 1}{e^{\delta_2} + e^{\delta_1 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})} + 1}$

Table 3.5: Adjustment Terms for Two Bonds

$a_{jnb}(\lambda)$	$\frac{1+\sum_{k=1}^{n} e^{\delta_k - \frac{\lambda}{1-\lambda}(\tau_{nb}-\tau_{jb})}}{1+\sum_{k=1}^{n} e^{\delta_k - \frac{\lambda}{1-\lambda}(\tau_{nb}-\tau_{kb})}}$

Table 3.6: Adjustment Terms for $n \geq 2$ Bonds

	Bond 1	Bond 2
Common Utility (δ_j)	0	0
Broker Fee (κ_j)	2.0%	3.0%
Seller Incentive (τ_j)	2.0%	3.0%

Table 3.7: λ Identification: Bond Product Characteristics

	$\lambda = 0$	$\lambda = 0.5$	$\lambda = 1$
s_1	0.33	0.24	0.17
s_2	0.33	0.42	0.50
s_0	0.33	0.33	0.33

Table 3.8: λ Identification: Market Shares

	UBS Bond	JP Morgan Bond
Common Utility (δ_j)	0	0
Broker Fee (κ_j)	2.0%	2.0%
Issuer Markup (η_j)	5.0%	5.0%
UBS Broker Firm Seller Incentive (τ_{jU})	4.5%	2.0%
JP Morgan Broker Firm Seller Incentive (τ_{jJ})	2.0%	4.5%

Table 3.9: μ_b Identification: Bond Product Characteristics

	UBS Broker Firm	**JP Morgan Broker Firm**	**Total**
Market 1	60	40	100
Market 2	80	20	100

Table 3.10: Number of Brokers

Market 1	UBS Broker Firm		JP Morgan Broker Firm		Market	
	s_{jU}	USD (mm)	s_{jJ}	USD (mm)	s_j	USD (mm)
UBS Bond	0.48	28.8	0.19	7.6	0.364	36.4
JP Morgan Bond	0.19	11.4	0.48	19.2	0.306	30.6
Bond 0	0.33	19.8	0.33	13.2	0.330	33.0
Total	1.00	60.0	1.00	40.0	1.000	100.0

Market 2	UBS Broker Firm		JP Morgan Broker Firm		Market	
	s_{jU}	USD (mm)	s_{jJ}	USD (mm)	s_j	USD (mm)
UBS Bond	0.48	38.4	0.19	3.8	0.422	42.2
JP Morgan Bond	0.19	15.2	0.48	9.6	0.248	24.8
Bond 0	0.33	26.4	0.33	6.6	0.330	33.0
Total	1.00	80.0	1.00	20.0	1.000	100.0

Table 3.11: μ_b Identification: Market Shares

Bond (j)	**Issuer** (f)	**Risk (Fair Value)** (v)	**Underlying Asset**
1	1	15	Apple
2	1	17	Apple
3	2	14	Apple
4	2	16	IBM

Table 3.12: Instruments Example

			Simple Logit	
			Exogenous Prices	**Endogenous Prices**
Broker Objective Function				
	Seller Incentive	λ	0.5753**	0.4666*
			(0.2533)	(0.2539)
	Issuer Profit	μ_b	0.2775	0.1821
			(0.2250)	(0.2646)
Investor Utility Function				
	Coupon	α	0.0142	0.0860*
			(0.0097)	(0.0488)
	Risk (Fair Value)	β	-0.0046	-0.0129*
			(0.0040)	(0.0069)
	Issuer FE		X	X
	Equity FE		X	X

Table 3.13: Simple Logit Demand Estimation Results

			Nested Logit	
			Exogenous Prices	Endogenous Prices
Broker Objective Function				
	Seller Incentive	λ	0.3157	0.4984***
			(0.2021)	(0.1156)
	Issuer Profit	μ_b	0.6475	0.8017**
			(0.4152)	(0.3242)
Investor Utility Function				
	Coupon	α	0.0140	0.3300
			(0.0119)	(0.7847)
	Risk (Fair Value)	β	-0.0269***	-0.0926
			(0.0049)	(0.0920)
	Nesting Parameter	σ	0.5927***	0.7844***
			(0.1189)	(0.0731)
	Issuer FE		X	X
	Equity FE		X	X

Table 3.14: Nested Logit Demand Estimation Results

in \$ (in %)	**No Agency Problem** ($\lambda = 0.00$)	**Partial Agency Problem** ($\lambda = 0.49$)	**More Severe Agency Problem** ($\lambda = 0.70$)
No Vertical Incentives ($\mu_b = 0.00$)	\$1,999,000 (11.68%)	\$396,000 (2.31%)	-\$5,152,000 (-30.11%)
Partial Vertical Incentives ($\mu_b = 0.80$)	\$1,999,000 (11.68%)	\$0 (0.00%)	-\$5,450,000 (-31.85%)
Full Vertical Incentives ($\mu_b = 1.00$)	\$1,999,000 (11.68%)	-\$58,000 (-0.34%)	-\$5,464,000 (-31.94%)

Table 3.15: Consumer Surplus per Market

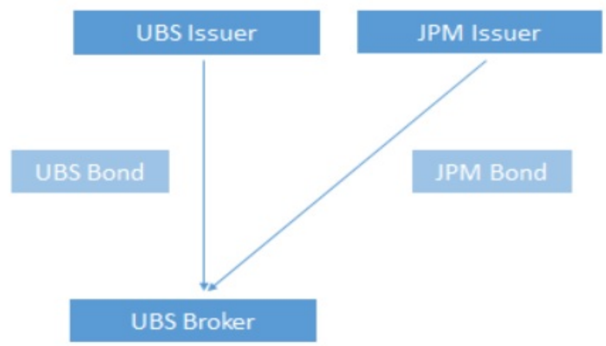

Figure 3.1: UBS Broker

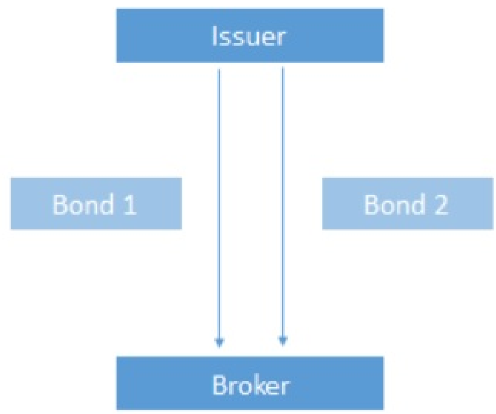

Figure 3.2: Two Bonds Example

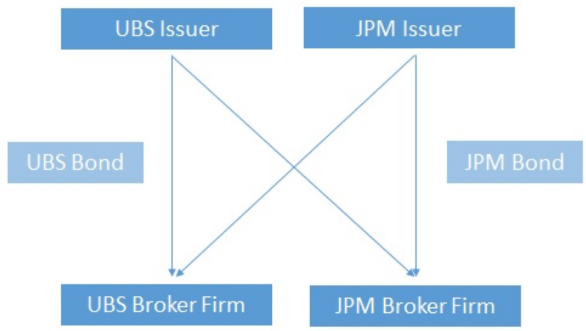

Figure 3.3: Two Broker Firms Example

Appendices

Appendix A

Market Share Equations

To begin with, assume two bonds and an outside option with $0 \leq \lambda < 1$ and $\tau_{1b} \leq \tau_{2b}$. Assume the simple logit utility function. I compute market shares of each bond by integrating over investor population which is represented by Equations (A.1)-(A.3).

$$s_{1b} = \int_{-\infty}^{x-\delta_2} \int_{x-\delta_1}^{\infty} \int_{-\infty}^{\infty} f_\epsilon^3 \, dxdydz + \int_{x-\delta_2}^{y-A_{12}} \int_{x-\delta_2+A_{12}}^{\infty} \int_{-\infty}^{\infty} f_\epsilon^3 \, dxdydz, \quad \text{(A.1)}$$

$$s_{2b} = \int_{x-\delta_2}^{\infty} \int_{-\infty}^{x-\delta_1} \int_{-\infty}^{\infty} f_\epsilon^3 \, dxdydz + \int_{x-\delta_2}^{\infty} \int_{x-\delta_1}^{z+A_{12}} \int_{-\infty}^{\infty} f_\epsilon^3 \, dxdydz, \quad \text{(A.2)}$$

$$s_{0b} = \int_{-\infty}^{x-\delta_2} \int_{-\infty}^{x-\delta_1} \int_{-\infty}^{\infty} f_\epsilon^3 \, dxdydz, \quad \text{(A.3)}$$

where $f_\epsilon^3 = \exp(-x-e^{-x}) \cdot \exp(-y-e^{-y}) \cdot \exp(-z-e^{-z})$, $A_{12} = \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b}) + \delta_2 - \delta_1$. Based on a type I extreme value distribution, I derive an analytical form for each market share.

$$s_{1b} = \frac{e^{\delta_1}}{e^{\delta_2} + e^{\delta_1} + 1} \cdot \frac{e^{\delta_2 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})} + e^{\delta_1 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})} + 1}{e^{\delta_2} + e^{\delta_1 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})} + 1} \quad \text{(A.4)}$$

$$s_{2b} = \frac{e^{\delta_2}}{e^{\delta_2} + e^{\delta_1} + 1} \cdot \frac{e^{\delta_2 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{2b})} + e^{\delta_1 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{2b})} + 1}{e^{\delta_2} + e^{\delta_1 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})} + 1} \quad \text{(A.5)}$$

$$s_{0b} = \frac{1}{e^{\delta_2} + e^{\delta_1} + 1} \quad \text{(A.6)}$$

It is straightforward to calculate a general form of market share equations.

$$s_{jb\,(1\leq j\leq n)} = \frac{e^{\delta_j}}{1+\sum\limits_{k=1}^{n} e^{\delta_k}} \cdot \frac{1+\sum\limits_{k=1}^{n} e^{\delta_k - \frac{\lambda}{1-\lambda}(\tau_{nb}-\tau_{jb})}}{1+\sum\limits_{k=1}^{n} e^{\delta_k - \frac{\lambda}{1-\lambda}(\tau_{nb}-\tau_{kb})}} \tag{A.7}$$

$$s_{0b} = \frac{1}{1+\sum\limits_{k=1}^{n} e^{\delta_k}} \tag{A.8}$$

Note that I label the n bonds by ascending seller incentive order, $\tau_{1b} \leq \tau_{2b} \leq ... \leq \tau_{jb} \leq ... \leq \tau_{nb}$.

Now I extend it to the nested logit model. Assume two bonds are members of inside goods $g = 1$ and an outside option is the only member of $g = 0$. By allowing investor tastes to be correlated across two bonds which depends on a nesting parameter σ, I derive an analytical form for each market share.

$$s_{1b} = \frac{\left(e^{\frac{\delta_2}{1-\sigma}} + e^{\frac{\delta_1}{1-\sigma}}\right)^{1-\sigma}}{\left(e^{\frac{\delta_2}{1-\sigma}} + e^{\frac{\delta_1}{1-\sigma}}\right)^{1-\sigma}+1} \cdot \frac{e^{\frac{\delta_1}{1-\sigma}}}{e^{\frac{\delta_2}{1-\sigma}} + e^{\frac{\delta_1}{1-\sigma}}} \cdot \frac{e^{\frac{\delta_2 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})}{1-\sigma}} + e^{\frac{\delta_1 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})}{1-\sigma}} + 1}{e^{\frac{\delta_2}{1-\sigma}} + e^{\frac{\delta_1 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})}{1-\sigma}} + 1} \tag{A.9}$$

$$s_{2b} = \frac{\left(e^{\frac{\delta_2}{1-\sigma}} + e^{\frac{\delta_1}{1-\sigma}}\right)^{1-\sigma}}{\left(e^{\frac{\delta_2}{1-\sigma}} + e^{\frac{\delta_1}{1-\sigma}}\right)^{1-\sigma}+1} \cdot \frac{e^{\frac{\delta_2}{1-\sigma}}}{e^{\frac{\delta_2}{1-\sigma}} + e^{\frac{\delta_1}{1-\sigma}}} \cdot \frac{e^{\frac{\delta_2 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{2b})}{1-\sigma}} + e^{\frac{\delta_1 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{2b})}{1-\sigma}} + 1}{e^{\frac{\delta_2}{1-\sigma}} + e^{\frac{\delta_1 - \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})}{1-\sigma}} + 1} \tag{A.10}$$

$$s_{0b} = \frac{1}{\left(e^{\frac{\delta_2}{1-\sigma}} + e^{\frac{\delta_1}{1-\sigma}}\right)^{1-\sigma}+1} \tag{A.11}$$

Again, it is straightforward to calculate a general form of market share equations.

$$s_{jb\,(1\le j\le n)} = \frac{\big(\sum\limits_{k=1}^{n} e^{\frac{\delta_k}{1-\sigma}}\big)^{1-\sigma}}{1+\big(\sum\limits_{k=1}^{n} e^{\frac{\delta_k}{1-\sigma}}\big)^{1-\sigma}} \cdot \frac{e^{\frac{\delta_j}{1-\sigma}}}{\sum\limits_{k=1}^{n} e^{\frac{\delta_k}{1-\sigma}}} \cdot \frac{1+\sum\limits_{k=1}^{n} e^{\frac{\delta_k-\frac{\lambda}{1-\lambda}(\tau_{nb}-\tau_{jb})}{1-\sigma}}}{1+\sum\limits_{k=1}^{n} e^{\frac{\delta_k-\frac{\lambda}{1-\lambda}(\tau_{nb}-\tau_{kb})}{1-\sigma}}} \qquad \text{(A.12)}$$

$$s_{0b} = \frac{1}{1+\big(\sum\limits_{k=1}^{n} e^{\frac{\delta_k}{1-\sigma}}\big)^{1-\sigma}} \qquad \text{(A.13)}$$

Note that market share equations in Equation (A.12) has a very general form in the sense that it becomes market shares in Equation (A.7) when $\sigma = 0$ and it becomes market shares in the standard nested logit model when $\lambda = 0$. It also becomes market shares in the standard logit model when $\sigma = 0$ and $\lambda = 0$.

Appendix B

Consumer Welfare Calculation

As in the previous appendix, I start with two bonds and an outside option. Assume $0 \leq \lambda < 1$, $\tau_{1b} \leq \tau_{2b}$, and the simple logit utility function. For broker firm b, I compute an expected utility by integrating over investor population which is represented by the following equations.

$$\begin{aligned} &\int_{-\infty}^{x-\delta_2}\int_{x-\delta_1}^{\infty}\int_{-\infty}^{\infty}(\delta_1+y)\cdot f_\epsilon^3\,dxdydz + \int_{x-\delta_2}^{y-A_{12}}\int_{x-\delta_2+A_{12}}^{\infty}\int_{-\infty}^{\infty}(\delta_1+y)\cdot f_\epsilon^3\,dxdydz \\ &+\int_{x-\delta_2}^{\infty}\int_{-\infty}^{x-\delta_1}\int_{-\infty}^{\infty}(\delta_2+z)\cdot f_\epsilon^3\,dxdydz + \int_{x-\delta_2}^{\infty}\int_{x-\delta_1}^{z+A_{12}}\int_{-\infty}^{\infty}(\delta_2+z)\cdot f_\epsilon^3\,dxdydz \\ &+\int_{-\infty}^{x-\delta_2}\int_{-\infty}^{x-\delta_1}\int_{-\infty}^{\infty} x\cdot f_\epsilon^3\,dxdydz, \end{aligned} \tag{B.1}$$

where $f_\epsilon^3 = \exp(-x-e^{-x})\cdot\exp(-y-e^{-y})\cdot\exp(-z-e^{-z})$, $A_{12} = \frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b}) + \delta_2 - \delta_1$. Based on a type I extreme value distribution, I derive an analytical form for an expected utility.

$$\begin{aligned} &e^{\delta_1}\cdot\frac{\log\left(1+e^{\delta_1-\frac{\lambda}{1-\lambda}(\tau_{1b}-\tau_{1b})}+e^{\delta_2-\frac{\lambda}{1-\lambda}(\tau_{1b}-\tau_{2b})}\right)+\gamma}{1+e^{\delta_1-\frac{\lambda}{1-\lambda}(\tau_{1b}-\tau_{1b})}+e^{\delta_2-\frac{\lambda}{1-\lambda}(\tau_{1b}-\tau_{2b})}} \\ &+e^{\delta_2}\cdot\frac{\log\left(1+e^{\delta_1-\frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})}+e^{\delta_2-\frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{2b})}\right)+\gamma}{1+e^{\delta_1-\frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{1b})}+e^{\delta_2-\frac{\lambda}{1-\lambda}(\tau_{2b}-\tau_{2b})}} \\ &+\frac{\log(1+e^{\delta_1}+e^{\delta_2})+\gamma}{1+e^{\delta_1}+e^{\delta_2}} \end{aligned} \tag{B.2}$$

where γ is the Euler-Mascheroni constant. It is straightforward to calculate an expected utility for $n \geq 2$ bonds given a broker firm b.

$$\sum_{j=1}^{n} e^{\delta_j} \cdot \frac{\log\left(1+\sum_{k=1}^{n} e^{\delta_k - \frac{\lambda}{1-\lambda}(\tau_{jb}-\tau_{kb})}\right)+\gamma}{1+\sum_{k=1}^{n} e^{\delta_k - \frac{\lambda}{1-\lambda}(\tau_{jb}-\tau_{kb})}} + \frac{\log\left(1+\sum_{k=1}^{n} e^{\delta_k}\right)+\gamma}{1+\sum_{k=1}^{n} e^{\delta_k}} \tag{B.3}$$

In order to get the consumer surplus, I aggregate this expression across all broker firms and divide it by the coupon coefficient α to convert to U.S. dollar terms. The consumer surplus for the simple logit utility function is,

$$\frac{1}{\alpha}\sum_{b} M \cdot \rho_b \left[\sum_{j=1}^{n} e^{\delta_j} \cdot \frac{\log\left(1+\sum_{k=1}^{n} e^{\delta_k - \frac{\lambda}{1-\lambda}(\tau_{jb}-\tau_{kb})}\right)+\gamma}{1+\sum_{k=1}^{n} e^{\delta_k - \frac{\lambda}{1-\lambda}(\tau_{jb}-\tau_{kb})}} + \frac{\log\left(1+\sum_{k=1}^{n} e^{\delta_k}\right)+\gamma}{1+\sum_{k=1}^{n} e^{\delta_k}}\right] \tag{B.4}$$

Finally, I extend it to the nested logit model case where I allow for a nesting parameter σ.

$$\frac{1}{\alpha}\sum_{b} M \cdot \rho_b \left[\sum_{j=1}^{n} \left(\sum_{k=1}^{n} e^{\frac{\delta_k}{1-\sigma}}\right)^{1-\sigma} \cdot \frac{e^{\frac{\delta_j}{1-\sigma}}}{\sum_{k=1}^{n} e^{\frac{\delta_k}{1-\sigma}}} \cdot \frac{\log\left(1+\left(\sum_{k=1}^{n} e^{\frac{\delta_k - \frac{\lambda}{1-\lambda}(\tau_{jb}-\tau_{kb})}{1-\sigma}}\right)^{1-\sigma}\right)+\gamma}{1+\left(\sum_{k=1}^{n} e^{\frac{\delta_k - \frac{\lambda}{1-\lambda}(\tau_{jb}-\tau_{kb})}{1-\sigma}}\right)^{1-\sigma}} + \frac{\log\left(1+\left(\sum_{k=1}^{n} e^{\frac{\delta_k}{1-\sigma}}\right)^{1-\sigma}\right)+\gamma}{1+\left(\sum_{k=1}^{n} e^{\frac{\delta_k}{1-\sigma}}\right)^{1-\sigma}}\right] \tag{B.5}$$

Note that the consumer surplus in Equation (B.5) has a very general form in the sense that it becomes the consumer surplus as in Equation (B.4) when $\sigma = 0$ and it becomes the consumer surplus in the standard nested logit model when $\lambda = 0$. Lastly, it becomes the log-sum consumer surplus in the standard logit model when $\sigma = 0$ and $\lambda = 0$.

Appendix C

Upstream Issuer Pricing

In this appendix, I model the way in which an upstream issuer sets coupons and broker fees. To begin, a multi-product issuer f has a profit function defined as follows.

$$\Pi_f = \sum_{j \in \mathcal{F}_f} \eta_j \cdot s_j + \mu_f \sum_b \{ I_{fb} \cdot \rho_b \sum_k \kappa_k \cdot s_{kb} \}, \tag{C.1}$$

$$\eta_j = v_j - c_j - \kappa_j, \tag{C.2}$$

where $\mu_f \in [0, 1]$: the extent to which an issuer internalizes its integrated broker firm profits, $\mathcal{F}_f$: a set of every bond issued by issuer f, s_j: the market share of bond j for all the broker firms, s_{kb}: the market share of bond k for broker firm b such that $\sum_k s_{kb} = 1$, $s_k = \sum_b \rho_b \cdot s_{kb}$. Similar to a broker firm case, an issuer considers broker profits if they are vertically integrated, but they discount them with μ_f.

First, in the equilibrium, an issuer sets coupons to maximize its profit. Given risks (fair values) and broker fees, every issuer f chooses coupons to maximize its profits Π_f across all bonds, which yields the next first-order condition:

$$\frac{d\Pi_f}{dc_j} = -s_j + \sum_{r \in \mathcal{F}_f} \eta_r \cdot \frac{ds_r}{dc_j} + \mu_f \sum_b \{I_{fb} \cdot \rho_b (\sum_k \kappa_k \frac{ds_{kb}}{dc_j})\} = 0. \tag{C.3}$$

Second, in a similar fashion, an issuer sets broker fees. Given risks (fair values) and coupons, every issuer f chooses broker fees to maximize its profits Π_f across all bonds, which yields the following first-order condition:

$$\frac{d\Pi_f}{d\kappa_j} = -s_j + \sum_{r \in \mathcal{F}_f} \eta_r \cdot \frac{ds_r}{d\kappa_j} + \mu_f \sum_b \left\{I_{fb} \cdot \rho_b \big(s_{jb} + \sum_k \kappa_k \frac{ds_{kb}}{d\kappa_j}\big)\right\} = 0. \tag{C.4}$$

It is worth to note that broker fee κ plays three different roles. First, it is nothing but effective marginal costs for issuers as issuers need to pay broker fees to brokers as seen in the first term of the right-hand side of equation below.

$$\Pi_f = \sum_{j \in \mathcal{F}_f} (v_j - c_j - \kappa_j) \cdot s_j + \mu_f \sum_b \{I_{fb} \cdot \rho_b \sum_k \kappa_k \cdot s_{kb}\}, \tag{C.5}$$

Second, it is also a part of perceived profits for issuers if issuers and brokers are vertically integrated as seen in the second term of the right-hand side of equation below.

$$\Pi_f = \sum_{j \in \mathcal{F}_f} (v_j - c_j - \kappa_j) \cdot s_j + \mu_f \sum_b \{I_{fb} \cdot \rho_b \sum_k \kappa_k \cdot s_{kb}\}, \tag{C.6}$$

Lastly, it provides an incentive to brokers as seen in the equation below.

$$\pi_{ijb} = \lambda \cdot \tau_{jb} + (1 - \lambda) \cdot u_{ij} \tag{C.7}$$

where $\tau_{jb} = \kappa_j + \mu_b \cdot I_{fb} \cdot \eta_j$

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