Real Effect of Credit Rating*
신용등급이 기업투자 행동에 미치는 영향

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This paper quantifies the causal effect of borrowing cost on firms' investment decisions. To overcome the empirical challenge due to a possible reverse causality where firms' investment prospects affect their borrowing costs, I apply an instrumental variable methodology where the identification comes from insurance companies' regulatory constraints regarding the credit rating of their bond holdings. Rating-based regulatory constraints are more binding for insurers with a weaker capital position. For this reason, bonds upon downgrades face different degrees of selling pressure depending on the different capital positions of their holders. Such differences are presumably not correlated with issuers' investment prospects. Using data from 2004-2010, I estimate that a one percentage-point increase in bond spread reduces investment during the same year by 12 percent. Moreover, a five percentage-point increase in bond spread halves the probability of new debt issuance.

Key Words: Credit Rating, Cost of Capital, Risk-Based Capital, Insurance Company, Corporate Bond

The cost of financing is one of the most important factors in a corporation's behavior.[1] The net present value of new project depends on cost of financing; therefore, firms make decisions on capital investment based on this information. However, measuring the effect of financing cost on investment decisions is challenging because cost of financing is also endogenously determined by corporate actions. If a firm lacks good investment opportunity or engages in inefficient projects, a bond investor would internalize these facts and raise the required risk compensation, thereby increasing the cost of financing. Therefore, directly running a regression of corporate actions on financing cost potentially yields biased coefficients. Ideally, one would run a random experiment, in which firms receive a random

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1) The terms of cost of financing, cost of debt of cost of borrowings are interchangeably used in this paper because I focus on the debt financing only.

shock to their cost of borrowing. In this experiment, the change in cost of borrowing is not related to any of corporate action or underlying risk. Examining the firm's behavior and decision upon such shocks would, therefore, enable econometricians to measure the causal effect of the cost of financing.

In this paper, I propose an approach with an instrumental variable to address the endogeneity concern and to quantitatively measure the causal effect of borrowing cost. A valid instrument variable should not be related to corporate decisions or firm's fundamental risk while it should have economic reasons to be correlated with the firm's cost of borrowing. The cross-sectional variation of bond investor's characteristics provides a basis for the instrumentation. One of the biggest corporate bond investors are insurance companies. They collectively hold about 30% to 40% of U.S. corporate bonds. This group of investors is highly regulated in terms of capital adequacy. These regulations eventually affect their portfolio choices. Insurers are required to keep their risk-based capital (RBC) ratio above a certain regulatory level. The RBC ratio is calculated as:

$$RBC\ ratio = \frac{Equity}{Risk\ Charged}$$

Credit rating of bonds in an insurer's portfolio is one of the factors *among other factors* that define the "Risk Charges". Bonds with low credit ratings have high risk charges, resulting in a lower RBC ratio. If the ratio falls below a certain threshold, the regulator of the state in which the company is registered will take over. Suppose that the RBC ratio of a certain insurance company is near the regulatory level. If a bond in the insurer's balance sheet is downgraded, the RBC ratio of the company would become even closer to the regulatory level.

There are two ways to raise the RBC ratio: (1) raising more equity or (2) selling the downgraded bonds. Since raising equity or injection of additional capital would take a long time than selling the downgraded bonds, the insurance company is more likely to sell the troubled bond. This fire-sale transaction would depress the bond's price and increases the issuer's spread. Once bonds are downgraded, the price pressure caused by fire-sales is particularly larger for bonds that are held by insurance companies whose RBC ratio is low.

The risk profile of the insurance companies holding a firm's bonds is exogenous to the firm's policy. The allocation of corporate bonds across investors is not a firm's decision. In the primary market, corporate bonds are typically allocated through underwriting process. Several investment banks form a syndicate that buys the entire issue and eventually distributes it to its clients (in this case, insurance companies). Hence, a firm cannot choose to be held by a particular group of investors. Hence, the cross-sectional variation of regulatory constraint across bond investors provides a valid instrument by imposing differential shocks to firms' borrowing cost upon downgrades.

The fire-sale mechanism due to the regulatory constraint investors is documented by Ellul, Jotikasthira, and Lundblad (2011). They find that bonds held by insurance companies with low RBC ratio experience much more severe price decline after the downgrade event relative to otherwise similar bonds held by insurance companies with high RBC ratio. While they document the price-relevant effect of fire-sales by insurance companies, I analyze the effect of the bond price departure due to the fire-sale to the issuing firms' policy.

Using the RBC ratio and bond position information of both life and property&casualty insurance companies from 2004 to 2010, I create a firm-specific variable that summarizes its bond investors' RBC ratio. Also, to measure the cost of borrowing, I create a firm-wide bond spread by aggregating the spread of each bond. Using the bond investor's RBC ratio as the instrument, the result of this paper suggests that 1 percent increase of the cost of borrowing has a causal effect on 12% reduction in capital flow. To measure the bias from endogeneity problem, I compare results from OLS regression which is not adjusted for the endogeneity. The comparison finds that such endogeneity understates the effect of cost of borrowing on the investment. I find results from the instrumental variable approach is 3,4 time bigger than results of Gilchrist and Zakrajsek (2007) that are consistent with OLS results.

This paper contributes to the strand of literature that document the real effect of security mispricing. Gilchrist, Himmelberg, and Huberman 2005) and Lou and Wang (2018) analyze how firm's investment sensitivity changes with respect to equity mispricing. The instrumentation of this paper for the security mispricing is similar to Edmans, Goldstein, and Jiang 2012), who use mutual funds' fire-sale events to measure the causal effect of stock price on the likelihood of take-over. Those papers focus on equity securities, while corporate bonds are the main focus of this paper. Gilchrist and Zakrajsek 2007) ask a similar question and measure the causal effect of bond spread on the capital stock. Unlike their approach, I rely on a specific economic mechanism to address a potential concern related to the reverse causality.

Since the identifying mechanism of this paper relies on the statutory references to credit ratings, this paper also contributes to general discussion about real effects of credit rating and rating agencies' behavior. Kisgen and Strahan 2010) study the effects of rating-based regulations on the cost of debt. They find that one-notch difference in credit rating corresponds to 39 basis points in the cost of capital. Together with their results, the findings of this paper help quantify the real effect of rating changes, through such statutory references to ratings. Moreover, Auh 2014) documents that rating standards become stricter in recessions relative to expansions, implying that firms receive overly harsh ratings in an economic downturn. As a result, the market spread of bonds tends to increase beyond a level reflecting the declined economic conditions. Findings of this paper and Auh 2014), taken together, suggest such procyclicality of rating standards may amplify the economic downturn, by imposing a further contraction of investment during recessions.

The analysis is based on two underlying assumptions. First, from the bond investor's perspective, new bonds and old bonds are close substitutes. That is, a bond investor should be indifferent between, say, buying a 5-year-old, 10-year bond and buying a fresh 5-year bond, by the same issuer. Then the secondary market yield affects the yield of new issues, and the firm must bear the higher cost of debt. If the existing bond has higher yield than the new bond, there is no reason for an investor to prefer the new bond over the old bond, because both are exposed to the same credit risk. For this reason, an issuing firm cannot issue new debt at a yield that is very different from that of existing debt. Indeed, I show that 1 percentage points increase of secondary yield in the previous quarter predicts about 50 basis points of increase in the cost of borrowing of the current quarter. Economic impacts of secondary yield through the observed prices of new bonds are understated. When financing conditions are adverse, a firm may even revoke a financing plan. Therefore, the firm is less likely to issue a new bond. I find that 5 percentage points increase of secondary yield cuts the probability of issuing a new bond by half.

Second, the price effect of such fire-sale event has to prevail long enough to affect firm's decision. If the spread increase is transient and disappears in very short period, it is not like to have any impact on firms' investments. Ellul et al. (2011) present evidence that the price reversal is slow. According to their finding, on average, the price dislocation on bond under fire-sale pressure lasts more than 30 weeks. One might think that the deviation of bond price due to the fire-sale should be immediately arrested by arbitrageurs in the market. Therefore, the argument is related to the notion of limits to the arbitrage or slow-moving capital. The effect of fire-sale on the asset price through mechanism of limits to arbitrage are well established both theoretically and empirically. Shleifer and Vishny (1997) propose a model where the fire-sale activity and further price departure from the fundamental value reinforces each other, creating limits to arbitrage. Kiyotaki and Moore (1997) show that this feedback channel can be exacerbated if the arbitrageurs are financed by debt, linking the declining value of a collateral asset and the downward spiral of the asset price. Brunnermeier and Pedersen (2008) develop a model where the price departure is caused by an interaction between market liquidity of the asset and borrowing constraints. The fire-sale effects on price are documented for general class of assets. Coval and Stafford (2007) shows that mutual funds that go through large outflows generate significant downward price pressures on equity securities they hold. Mitchell and Pulvino (2012) provide evidence that the relative price divergence across similar assets, including convertible bonds and credit default swaps, was very high at the peak of the financial crisis of 2008.

The structure of the paper is as follows. Section I considers a simple illustration to motivate the insight for identification. Sections II provides data description and summary statistics. Section III describes the empirical methodology with discussion of its validity. Section IV presents the results regarding the causal effect of cost of borrowing on firms' investment decisions. Section V provides supporting evidence on assumptions. Section VI conclude.

Ⅰ. Motivation for Identification Strategy

The key identification strategy is that it is not a decision of an issuing firm whether its bonds to be held by good insurance companies (with a high RBC ratio) or bad insurance companies (with a low RBC ratio). Consider two identical issuing firms, A and B. Since they have equivalent underlying risk, the price of their bonds should be also identical. The bond of firm A happens to be bought by a good insurance company and that of firm B is held by a bad insurance company. Now suppose that they receive some negative economic shocks, hence both bonds are downgraded (they are identical firms). As a result, the RBC ratios for both bond investors decline. However, the RBC ratio of the insurance company that holds firm B's bond becomes even closer to the regulatory level. Therefore, the RBC constraint for the bad insurance company is more likely to bind and this insurer is forced to sell the bond. This fire-sale transaction increases the bond spread of firm B relative to that of firm A.

During the period that the price dislocation prevails, firm B must pay a relatively higher cost of financing. Also, compared to firm A, B is more likely to even retract the plan to issue a new bond as it expects high funding cost. Hence, this change in cost of borrowing would affect the corporate decision to start a new project. The net present value of the project, which would have been otherwise positive, may become negative with the elevated cost of funding. These decisions will be expressed as the change in capital expenditures. Note that, in this hypothetical illustration, the only difference between these two firms is the variation in investors' characteristics that are out of the issuer's control. Therefore, the difference of investment policies between firm A and firm B arises from the relative difference in the cost of borrowing, and this makes it possible to measure its causal relationship.

Ⅱ. Data Description

I start from non-financial public firms in U.S. stock exchanges, covered by Compustat from 2004 to 2010. To these firms, I merged Capital IQ data to add more variables. Further, I match two different sources of information to construct the sample data. The first source is the TRACE database that contains the secondary trading marks of corporate bond for the sample period. To this database, I merge the detailed bond information such as maturity dates, coupon rates or call features from the FISD database. The spread of a bond is defined as the difference between yield of the bond and yield of a benchmark risk-free security. Therefore, the bond spread captures a risk compensation to the investors for the firm-specific credit risk that they bear, for a given time. The bond spread is the normalized cost of borrowing because subtraction of the bench- mark yield eliminates the time variation of common risk in the macro economy. For the risk-free benchmark yield, I use yield of U.S. treasury bond. U.S. treasury issues series of bonds with different durations. However, it does not always issue the whole spectrum of bonds in terms of the maturity. Hence, yields of certain maturities are not available in some quarters. In this case, I interpolate or extrapolate the missing points using cubic-spline fitting methodology.[2] Using this information, I create duration-yield pair of benchmark securities in quarterly basis. To construct a corporate bond spread, I classify the bond yield in the duration bucket and subtract the benchmark yield from the same bucket. For some corporate bonds, their duration is significant longer (as long as 40 year) than the maximum duration from 30-year treasury bond (about 15 year). In this case, I assign a benchmark yield from the maximum duration for these long-maturity bonds.

The resulting bond-level data contains 408,691 bond-quarter observations or 42,832 unique number of bonds. Panel (I) of Table 1 provides the summary statistics of selected variables. I use this set of data for analyzing how the secondary yield influences the yield at issuance or the probability of issuing a new debt

2) Cubic-spline fits a curve to the data points by minimizing the curvature of the fitted curve.

in Section V. To examine the effect of borrowing cost to firms' behavior, I further create quarterly firm-wide borrowing cost by aggregating these bond spreads, using a weight of trading volume of each bond. Finally, to match with the balance sheet data at annual frequency, I create the average spread of a firm of the last 4 quarters, denoted by *Spread*.

The second source is the quarterly holding information of life insurance and property& casualty insurance companies from the National Association of Insurance Com- missioners (NAIC) from 2004 to 2010. NAIC is the regulatory support body created by insurance regulators of each state in U.S. territory. The regulated insurers are required to report their holding and transaction information of their asset to NAIC in quarterly basis. The holding data provide detail information about the asset position of reporting insurers (information about bond-investor pair) as well as bond specific information such as bond ratings and market yields. Further, I match the RBC ratio information to the insurance companies' bond holdings at each quarter. As fully explained in the Appendix, the RBC ratio is determined by surplus capital and various risk factors including bonds' credit ratings. The RBC ratio considers generally three aspects of risk: asset risk, insurance risk, and business risk. The asset risk captures risks that come from insurance companies' asset composition such as fixed income securities, equity and other derivatives. Through the asset risk calculation, credit ratings of bonds in the balance sheet affect the RBC ratio. The insurance risk is related to the insurer's liability. For example, a variation of insured individuals in terms of mortality (or a fluctuation of the mortality) is one of risk factors for life insurance companies. The business risk generally captures operation risk such as a growth of the litigation cost.

Using this data, I create an issuing firm-specific variable that summarizes the RBC ratio of the firm's investors (insurance companies) at each quarter, denoted by RBC_I. To construct this variable, for each borrowing firm, I aggregate the RBC ratios of firms' investors weighted by bond size in the balance sheet of each bond holder. Therefore, the RBC_I would depend more on the RBC ratio of major bond holders of the firm than other holders whose positions are not substantial. There are firms whose bonds are not held by any of reporting insurance companies. These firms do not experience the forced fire-sale due to the regulation constraint of insurance companies. For the analysis, I assume that these firms are held by a hypothetical insurance company with very high level of the RBC ratio (at 90th percentile of the distribution of the RBC ratio) so that the insurer has little motivation to sell the bonds to boost the RBC ratio. The resulting database constitutes a panel data of firms with the collective RBC ratio of their

〈Table 1〉 Summary Statistics

(I) Bond-level Data

	Mean	St.Dev.	25th Pct.	Median	75th Pct.	N
Quarterly Yield	7.8%	0.09	4.9%	5.8%	7.3%	408691
Quarterly Spread	4.8%	0.10	1.0%	2.3%	4.4%	408691
New Bond	2.7%	0.16	-	-	-	408691

(II) Issuer-level Data

	Mean	St.Dev.	25th Pct.	Median	75th Pct.	N
△CAPEX	8.6%	38.1%	-17.4%	4.8%	27.6%	2973
Leverage	49.8%	21.9%	33.5%	46.8%	62.0%	3328
Log(Market Cap)	8.15	1.54	7.07	8.19	9.34	3803
Log(Asset)	8.52	1.30	7.56	8.48	9.55	3958
Book/Market	1.77	1.30	0.85	1.36	2.22	3803
Tobin's q	1.24	0.54	0.83	1.08	1.49	3803
RBC_I	8.27	1.24	7.41	8.23	9.27	3958
Spread	4.1%	4.0%	1.7%	3.0%	5.0%	3958

These tables present summary statistics of selected variables for (I) bond-level data and (II) issuer-level data. In the bond-level data, Quarterly Yield indicates the quarterly trading-volume weighted average of bond yield either from primary and secondary markets. Quarterly Spread means the quarterly trading-volume weighted average of bond spread in which the bond spread is the difference between the bond yield and benchmark yield in the same duration bucket. New Bond indicates the fraction of newly issued bonds in the sample. In the issuer-level data, △CAPEX is defined as: $CAPEX_t/CAPEX_{t-1} - 1$. Leverage is total debt over total capital (total debt + total equity). Tobin's q is defined as: (Market Equity+Book value of debt)/ Book value of asset. RBC_I is the firm-wide variable that summarizes the RBC ratio of the firm's investors (insurance companies). *Spread* is the 4-quarter average of firm-wide bond spread in which firm-wide bond spread is the bond-size weighted average of individual bond spread of the firm.

bond investors (RBC_I) and their firm-wide bond spread (*Spread*) as well as other information from the financial statements. The data includes 3958 firm-year observation or 914 unique firms. Panel (II) of Table 1 presents summary statistics of selected variables.

Ⅲ. Research Methodology

3.1 2SLS IV

The key scope of this study is to measure the causal effect of cost of debt to a firm's investment decision. Specifically, I estimate the following form:

$$\triangle \text{Investment} = \beta \cdot \text{Spread} + \lambda \cdot X + e, \quad (1)$$

where △Investment is the change in capital flow measured by percentage change of capital expenditures, Spread is a 4-quarter average of firm-wide borrowing cost, and X is a vector of control variables. The coefficient of the interest would be β. However, it is difficult to make a causal statement from the coefficient. In the efficient market, a firm's investment prospects, or any future likelihood of investment policy is typically priced in, changing the bond spread. The coefficient may be biased due to this potential reverse causality because, in this case, the residual term e is correlated with *Spread.*

To avoid this possibility, I employ 2-stage least-square regression with instrument variable (2SLS-IV). The first stage regression for the endogenous variable Spread in Equation (1) is

$$Spread = a \cdot RBC_I + \gamma \cdot \tilde{X} + \tilde{e}, \quad (2)$$

where RBC_I is a firm-wide collective RBC ratio of its bond investors, and $\tilde{X}$ is a vector of control variables. When there is a rating downgrade, bond spread generally increases. However, for a given rating downgrade, the spread is likely to increase even further if the bond is held by an investor that is more forced to sell it, i.e., $corr(Spread, RBC_I) \neq 0$. On the other hand, allocation of the bond across different insurance companies is not a firm's choice. Therefore, the RBC ratio of its investor is exogenous to firm's policy, i.e., $corr(\triangle Policy, RBC_I) \approxeq 0$.

3.2 Exclusion Restriction of IV

To use the RBC ratio as an instrument, it is necessary to satisfy an exogeneity between the firm's policies and allocation of their bonds across insurance companies. Firms are not likely to consider their investor's RBC ratio when they decide the investment policy, nor are firms likely to choose investors by their RBC ratios. However, this does not assure that there is no economic correlation between the RBC ratio and firms' investment policy. I can think of two possibilities for such a correlation. First, insurance companies with a certain risk profile may intentionally pick bonds of firms that have common characteristics. If these characteristics are likely to affect firms' future investment, then it is possible to have a correlation between RBC ratio and the investment decision.

Any such a correlation may vitiate the result from IV approach. However, it is not certain that a bond investor would necessarily prefer firms that are expected to increase their investment. New and potentially risky investment may shift risk from equity holders to bond holders (Jensen and Meckling (1976)). Therefore, there is no obvious reason that an insurance company with a certain range of RBC ration would prefer holding bonds, according to their prediction about the issuer firms' investment policy.

To further show that insurance companies' RBC ratio are not correlated with firms' future investment policy, I examine several characteristics of issuing firms across RBC ratio of their investors. Specifically, I classify insurers into two groups by their RBC ratio:

high RBC ratio group and low RBC ratio group. In Table 2, I show that, at the time of purchasing bonds, there are no significant differences in several variables of firms that can be relevant to future investment between the two groups of investors. The table presents that 4-quarter average of investment trend (Inv. Ratio), profitability (NI Ratio), and estimated investment opportunity (Tobin's q) of issuing firms are not statistically different, at the time of purchasing bonds, between each group by RBC ratio. Also, 4 quarter average rating changes (Notches Chg.) and yield (Yield) of purchased bonds are not significantly different. There is also no significant difference in firm size (Mkt. Val.), firm characteristic (Book/Mkt.), and industry (Industry) of issuing firms between two investor groups. While these variables may allow investors to predict firms' future investment, similarity of these variables supports the exclusion restriction that that RBC ratios of investors are not correlated with investment decision.

Ⅳ. Result and Discussion

For each firm-year observation in the sample, I create a variable that indicates a firm

〈Table 2〉 RBC ratio and Variables Relevant to Future Investment

	Low RBC (mean = 4.41)		High RBC (mean = 17.88)			
Variables	Mean	N	Mean	N	Diff.	t-stat
Inv. Ratio	7.2%	57417	7.3%	54858	-0.1%	-1.5969
NI Ratio	7.8%	84517	8.0%	80021	-0.2%	-0.4225
Notches Chg.	-0.0015	95037	-0.0013	90362	-0.0002	-0.2912
Tobin's q	1.2766	61870	1.2813	62024	0.00	-1.1087
Yield	6.0%	39461	5.6%	34673	0.4%	1.1062
Mkt. Val.	37059	64253	37270	64378	-211	-0.7684
Book / Mkt.	3.0	64243	2.9	64373	0.0	0.8347
Industry	30.6	92980	30.6	88038	0.0	0.1247

This table presents statistical difference of several variables relevant to future investment and characteristics of issuing firms between insurance companies with high RBC ratio and low RBC ratio at the time of purchasing bonds. Inv. Ratio is 4 quarter average of investment ratio = I_t/K_{t-1} where K_t is a level of property, plant, and equipment at the end of period t and I_t is investment during the period t. NI Ratio is defined as Net Income/Revenue. Notches Chg. is net change of ratings in the past 4 quarters. A positive number of Notches Chg. means the bond's rating has been downgraded in the period. Tobin's q = (Market Equity + Total Debt) / Book Asset. Yield is average yield of a bond in the past 4 quarters if any traded yields are available. Mkt. Val. is market value of equity of issuing firm. Book / Mkt. is defined as Book Value Asset / Market Value Equity. Industry is number-coded according to Fama-French 49 industry classification.

has any downgrade on any of its obligations in the past 4 quarter period.[3] If a bond is downgraded, then its spread and eventually cost of borrowing increase accordingly. The higher cost of borrowing causes a reduction in the investment. In Table 3, I present regression results from the OLS regression and the 2SLS-IV specified in Equation (1) and (2), respectively. Comparison of results from these two models uncovers the potential bias due to the endogeneity. For both regressions, the coefficients β are consistently negative and significant in all specifications. This means that when the spread increases, there is a reduction in investment. However, coefficients from OLS regression are much smaller than those from 2SLS-IV, confirming that the endogeneity creates the upward bias on the coefficient.

The results from 2SLS-IV allow me to make a causal interpretation: 1% change of the spread corresponds to about 12% contraction of capital flow which is measure by $Capex_t/Capex_{t-1} - 1$, where *Capex* is the capital expenditure from firms' income statements. More intuitively, I find that, when the borrowing cost increases by 1 percent, an average firm reduces the capital expenditure to 88 cents from 1 dollar. Also, the results suggest that the price dislocation from the investors' regulatory constraint prevails in the market long enough to have an impact on firms' investment decision. In fact, Ellul et al. (2011) reports that the abnormal return between bonds in two constrained groups (bonds held by insurance companies with high and low RBC ratio) lasts about 35 weeks after a downgrade event.

In the similar context, Gilchrist and Zakrajsek (2007) document that the 1 percent change of the bond spread reduces 50 to 70 basis point of investment rate. Their definition of investment rate is I_t/K_{t-1}, where I_t is the nominal investment during period t and K_t is book value of net property, plant, and equipment at the end of period t. The investment I can be backed out from the innovation of the capital $K_{t+1} = K_t + I_t - \delta_t$, where δ_t is a depreciation during period t. To compare my results with theirs, I replicate their measure of investment rate and repeat the analysis. I find that the magnitude of effect in Table 3 is much larger than theirs: my results correspond to 1.8% -- 2.1% reduction on the rate of investment, which is 3 or 4 times bigger than their results. Their result is consistent with my findings from OLS approach that does not correct biases from the endogeneity. I contemplate several explanations for this difference. First, their strategy to tease out the causal effect of borrowing cost on invest-

3) For this analysis, the downgrade is defined by the NAIC. The NAIC takes the bond ratings from Nationally Recognized Statistical Rating Organization (NRSRO) designated by SEC, such as S&P, Moody's or Fitch. When all of the rating agencies in the NRSRO system downgrades then NAIC also downgrades, and the insurance companies' RBC ratio will be affected.

〈Table 3〉 Result of IV Regression

	OLS				2SLS-IV			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Spread	-0.02***	-0.02***	-0.03***	-0.03***	-0.13**	-0.12**	-0.12**	-0.12**
	(-11.88)	(-11.03)	(-10.24)	(-10.37)	(-2.30)	(-2.12)	(-2.05)	(-2.06)
Tobin's q		0.03**		0.09***		-0.05		0.04
		(2.28)		(2.70)		(-0.35)		(0.33)
Leverage			0.08*	0.02			0.72**	0.69*
			(1.94)	(0.32)			(1.98)	(1.94)
Log(MktValue)			0.03*	-0.03			-0.14	-0.16
			(1.84)	(-1.11)			(-0.87)	(-0.87)
Log(Asset)			-0.06***	-0.00			-0.00	0.02
			(-3.82)	(-0.00)			(-0.03)	(0.17)
Industry	N	N	Y	Y	N	N	Y	Y
N	2973	2865	2416	2416	494	472	414	414

This table presents the result of OLS and 2SLS-IV regression in Equation (1) and (2), respectively. The columns from (1) to (4) report the results from OLS regression and the columns from (5) to (8) report from the results from 2SLS-IV regression. The LHS variable △Investment is defined as the percentage change of capital flow, $\triangle Investment_t = (CAPEX_t/CAPEX_{t-1}) - 1$. Spread is the value-weighted bond yield from TRACE less benchmark treasury yield (from same duration bucket). Tobin's q is defined as (Book value of debt + Market value of equity) / Book asset value. Leverage is a ratio of total debt over total capital. Log(MktValue) is logarithm of market value equity. Log(Asset) is logarithm of book asset value. The firm industry is controlled according to Fama-French industry classification when Industry row indicates "Y".

ment decision depends on a model specification and it may not fully address potential bias. Second, a reduction on the investment due to increase in the borrowing cost may be particularly stronger through the channel of statutory references to ratings.

Ⅴ. Additional Analysis

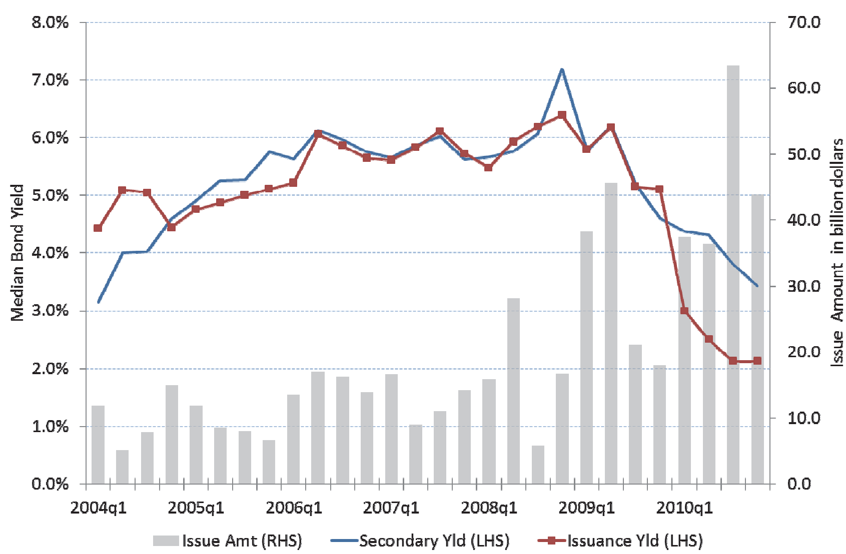
5.1 Close Substitutability between Existing Debt and New Debt

Forced sale due to the regulation constraint of the insurance companies creates yield spike in the secondary market. The secondary yield of bonds is not the direct cost of borrowing from a firm's perspective. The issuing firm's cost of debt is determined by a contractual interest rate that the firm promises to pay creditors when the bond is newly issued. Once the bonds are issued, it can be freely traded in the secondary market and the transaction price among bond investors determines the secondary yield. Even if a bond is traded at a yield which is significantly different from the initial yield, that risk compensation is not borne by the issuing firm.

However, the secondary price of bonds

affects the initial price of the bond which is directly related to the firm's borrowing cost. This is because, for an investor's perspective, old bonds on the secondary market are arguably close substitutes of a newly issued bond of a certain firm. In other word, for a given secondary market yield, the firm is not able to issue a new debt at very different (obviously, lower) yield. If a firm sets the price high for a new bond when the secondary price of bonds from same issuer is much lower, then investors have no incentive to pay more to buy the new bond because both bonds' payout depends on the same underlying credit worthiness of the firm. The substitutability of different bonds from same issuer is documented in previous literature such as Crabbe and Turner (1995) in which they show that bonds with different size from the same issuer are also close substitutes.

Figure 1 shows the time series of median yield of bonds in secondary market and initial



This plot shows the time series of the median yield of bonds in the secondary market and yield of bonds at the issuance in the sample period from 2004 to 2010. Specifically, among firms that have at least one issuance of new bond in each quarter, I calculate the average firm-quarter bonds yield in the secondary market, weighted by trade volume, excluding the yield of bonds the firms issued in the quarter. The median of these secondary yield is presented in the solid line (LHS). Also, I calculate the average firm- quarter yield of new bonds in the quarter, weighed by issuance size. The median of these yields at issuance is presented in the line with square marker (LHS). Bars in the plot (RHS) indicate the total issue amount in the sample firms. The unit of bars is billion U.S. dollars.

〈Figure 1〉 The Time Series of Secondary Yield and Yield at Issuance

4) It is analogous to the price difference between "on-the-run" treasury bond and "off-the-run" treasury bond.

yield at the issuance of firms that have at least one issuance in each quarter. The figure shows that they are almost identical over time. Since old bonds and a new bond have the same issuer, an investor is exposed to same credit risk of underlying firm. While same exposure to the credit risk generally makes secondary yield and initial yield similar, they can be a disparity if there are differences in liquidity of old bonds and a new bond. Generally, bonds become less liquid after they are issued. The scarcity of old bonds can make their trading price higher.[4)] The liquidity premium may contribute to the small difference between the two curves in the figure. This explanation is consistent with Collin-Dufresne, Goldstein, and Martin (2001) who show that the credit spread is locally affected by liquidity as well as the supply and demand shocks. Nevertheless, the figure shows that the secondary bonds yield and initial yield cannot be far apart.

I further perform a predictive regression of firms' initial yield at the issuance on their secondary yield. If the yield of exiting bonds traded in the secondary market changes in the current period, then the initial yield of new bonds to be issued in the following period will be affected. In other words, the current secondary market price of bonds has a prediction power to the price of new bonds in the future. This is because, once an investor observes the secondary market yield, they will demand similar risk compensation for the newly issuing bond. To test this hypothesis, I perform the regression specification as follows:

$$Cost_{i,t} = \beta_0 + \beta_1 \cdot Secondary_{i,t-1} + \beta_2 \cdot Secondary_{i,t-2} + \lambda\, FE + e_{i,t} \quad (3)$$

where $Cost_{i,t}$ is the issue-size-weighted initial yield or spread that firm i pays at quarter t, $Secondary_{i,t}$ is the trading-volume-weighted secondary yield or spread of firm i's existing bonds at quarter t. When the bond yield is used for $Cost$, a part of its variation may be due to the common factor from the macroeconomic condition. The changes of borrowing cost due to the time-varying macro factor should be eliminated, to measure its dependency on the secondary yield. To address this, I include the time fixed effect, FE, when yield is used for the left-hand side variable for Equation (3).

5.2 Effects of Spread on Decisions to Issue New Bonds

The analysis in Equation (3) is from the observation of an equilibrium outcome. It might not capture the full effect of the secondary yield on the economy because a firm may forgo the plan of the issuance when their secondary yield is high enough, with an expectation of worsen financing condition. In this case, the effect through the decision change would not even show in the data of spreads. I also find that the decision to issue new bond is affected by the secondary yield. The following logit regression specification is used to test this:

$$Pr(I_{i,t} = 1) = \pi\{\beta_0 + \beta_1 \cdot Secondary_{i,t-1} + \beta_2 \cdot Secondary_{i,t-2} + \lambda \cdot FE + e_{i,t}\} \quad (4)$$

where $I_{i,t}$ takes value of 1 if there is at least one new issuance of bonds, and $\pi\{\cdot\}$ is the logistic distribution function. The other variables have same definition as in Equation (3).

The columns from (1) to (3) in Table 4 reports the regression results of Equation (4). They consistently show that lagged values of the secondary yield or spread positively affect the contemporaneous cost of borrowing in the primary market. Columns (1) and (2) indicate that 1 percentage point increase of the last quarter's secondary yield has a positive effect on this quarter's initial yield as much as about 50 basis points. Similarly, column (3) shows that, on average, initial spread increases by 32 basis points when last quarter's secondary spread rises by 1 percentage point. Columns from (4) to (6) of the table present the result of regression specified in Equation (4). They confirm that increase in the secondary yield or spread makes the issuance of new debt less

〈Table 4〉 Predictability of Secondary Bond Yield

	Cost of Borrowing			Decision to Issue		
	(1)	(2)	(3)	(4)	(5)	(6)
Secondary Yield (lagged 1)	0.58***	0.50***		-0.11***	-0.07***	
	(4.88)	(3.80)		(-4.68)	(-4.28)	
Secondary Yield (lagged 2)	-0.05	0.03		-0.02	-0.03**	
	(-1.60)	(0.43)		(-1.14)	(-2.03)	
Secondary Spread (lagged 1)			0.32**			-0.08***
			(2.56)			(-4.52)
Secondary Spread (lagged 2)			0.04			-0.03**
			(0.44)			(-2.32)
Time FE	N	Y	N	N	Y	N
R2	0.44	0.29	0.05	0.02	0.14	0.02
N	285	285	285	70739	21260	70714

This table presents the regression specification in Equation (3) (column (1) to (3)) and Equation (4) (column (4) and (6)). The left-hand side variable for the regression in the column (1) and (2) is the current bond yield at issuance. The left-hand side variable for the regression in column (3) is the current bond spread at issuance. Columns (1) to (3) are estimated by OLS model. The left-hand side variable for regression in the columns (4) to (6) is the indication variable about firms' decision of issuing a new debt in the quarter (1 if it issues; 0 otherwise) and they are estimated by logit model. Time fixed effect is used when the independent variables are bond yields to capture the time variation of the reference interest rate (column (2) and (5)). For logit model (column (4) to (6)), the pseudo R-square, calculated by the improvement of log likelihood, is reported.

likely by showing negative and significant coefficients. The marginal probability of the first lagged variable is about 25 basis points. If there is a 1 percentage point change in the yield or spread, then the probability of issuance drops by 25 basis points. It may not look a big effect but given that the unconditional probability of issuance is only about 2.7%, hence 5% changes of the secondary yield would cut the issuance event by half.

The Figure 1 and Table 4 provide evidence that the secondary market price of bond has an important implication on the cost of borrowing and firms' financing decision. The results further confirm the mechanism that when a firm receives differential price shock in the secondary market due to a cross-sectional variation of regulatory constraints of its bond holder, the firm also faces differential shocks on the borrowing cost and financing decision.

5.3 Implication of Credit Rating Standard

In this paper, causal effects of the cost of borrowing on the real economy is identified through a channel of the regulation based on credit ratings. Therefore, my findings have an implication to general discussions about importance of information quality in credit ratings. In fact, insurance companies are not the only institutional investor that is subject to holding/capital regulations based on credit ratings. Broker-Dealers, banks, money market mutual funds, and pension funds have similar provisions.[5] In the presence of the statutory references to ratings, there is a hard-wired selling pressure of bonds upon rating downgrade. Hence, rating changes for *any* reason may result economic consequences via changes of borrowing cost. Suppose that a bond has a rating downgrade for some reason that is not relevant to credit risk of the issuer. Even in this case, the issuer of the bond may face higher borrowing cost because investors are forced to sell this bond due to such a regulation.

In particular, Auh (2014) shows that credit rating agencies implement tougher rating standard in recessions and more lenient one in expansions for their own incentive. He finds that this "procyclical rating standards" explains 15 basis points of spread increase in recessions. Using the findings in Section IV, the price effect due to the procyclical rating policy corresponds to about 1.8% of capital flow. Intuitively, without the changes of rating standards, 1.8% of reduction in investment could have been avoid during recessions. Putting together, these results suggest that the business cycle may be amplified due to regime-inconsistent rating standard.

5) See Auh (2014) for detailed discussions.

Ⅵ. Conclusion

In this paper, I quantify the causal effect of cost of debt to firms' investment decisions through insurance companies' capital regulation based on credit ratings. The bonds are exogenously allocated over investors with different levels of RBC ratio. When a downgrade event occurs, firms held by insurance company with lower RBC ratio face stronger downward pressure on prices, resulting in higher bond spread. This price dislocation due to the fire sale of constrained insurance companies affects borrowing cost of these issuers and tends to last long enough to influence firms' investment decision, creating a real consequence. This paper implies that when investors are subject to holding/capital regulation strictly based on credit rating, changes of credit ratings for *any* reason, may have a significant effect in the economy. In this respect, findings of this paper also suggest that the economy may be vulnerable to any time-inconsistent or inaccurate rating standard.

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〈Appendix〉 RBC Ratio Calculation

I present the RBC ratio formula for Life and Property&Casualty insurance companies. The following calculation shows that RBC ratio is determined by various factors including bond ratings in their portfolio. More detailed information can be found at NAIC's Risk-Based Capital for Insurers Model Act (Volume II-312). RBC ratio is defined as:

$$RBC\ ratio = \frac{Statutory\ Surplus}{Risk\ Charged}$$

where Statutory Surplus is a capital of the insurance company and Risk Charges are calculated as follows:

1. Life Insurance Risk Charges

$$C0 + \sqrt{(C1_o + (C3_a) + (C1_{cs} + (C3_c)^2 + (C2)^2 + (C3_b)^2 + (C4_b)^2} + (C4_a)^2\ ,$$

where:

- $C0$ = Insurance affiliate investment and (non-derivative) off-balance sheet risk
- $C1cs$ = Invested common stock asset risk
- $C1o$ = Invested asset risk, plus reinsurance credit risk except for assets in C1cs
- $C2$ = Insurance risk
- $C3a$ = Interest rate risk
- $C3b$ = Health provider credit risk
- $C3c$ = Market risk
- $C4a$ = Business risk - guaranty fund assessment and separate account risks
- $C4b$ = Business risk - health administrative expense risk

2. Property and Casualty Insurance Risk Charges

$$R0 + \sqrt{R1^2 + R2^2 + R3^2 + R4^2 + R5^2}\ ,$$

where:

- *R0* = Insurance affiliate investment and (non-derivative) off-balance sheet risk
- *R1* = Invested asset risk - fixed income investments
- *R2* = Invested asset risk - equity investments
- *R3* = Credit risk (non-reinsurance plus one-half reinsurance credit risk)
- *R4* = Loss reserve risk, one half reinsurance credit risk, growth risk
- *R5* = Premium risk, growth risk