Journal of Financial Economics 110 (2013) 185–214

Contents lists available at ScienceDirect

Journal of Financial Economics

journal homepage: www.elsevier.com/locate/jfec

Supply uncertainty of the bond investor base and the leverage of the firm ☆

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ARTICLE INFO

Article history:
Received 31 January 2011
Received in revised form
21 January 2012
Accepted 19 March 2013
Available online 4 May 2013

JEL classification:
G1
G2
G3
G22
G23
G32

Keywords:
Institutional investors
Corporate bonds
Bond capital supply uncertainty
Capital structure
Investor base

ABSTRACT

We examine the effect of the bond capital supply uncertainty of institutional investors (e.g., mutual bond funds and insurance companies) on the leverage of the firm using a novel data set. Our main finding is that the supply uncertainty of the firm's bond investor base — measured as (i) the average portfolio turnover, or (ii) the average flow volatility of investors holding the firm's bonds, or (iii) the prevalence of mutual funds among the firm's bondholders as opposed to insurance companies — has a negative and significant effect on the leverage of the firm. The supply uncertainty of the firm's bond investor base also has a negative and significant effect on the firm's probability of issuing bonds, and a positive and significant effect on the firm's probability of issuing equity and borrowing from banks. We take a multi-pronged approach to address potential endogeneity issues, including use of geography-based instruments and firm fixed effects, subsample analyses, and a placebo test. Our results highlight the fragility of access to the bond market for companies that depend on mutual funds with high turnover/ flow volatility as primary bond investors.

☆ We thank Tim Adam, Franklin Allen, Heitor Almeida, Yakov Amihud, Andrew Ang, Malcolm Baker, Dan Bergstresser, Mark Carey, Joshua Coval, Doug Diamond, Greg Duffie, Philip Dybvig, Ken Eades, Gary Gorton, Denis Gromb, Diana Hancock, Harrison Hong, Jennifer Huang, Wei Jiang, Kose John, Mark Leary, Vojislav (Max) Maksimovic, Leslie Marx, Hamid Mehran, Andrew Metrick, Holger Mueller, David Musto, George Pennacchi, Gordon Phillips, Paul Pfleiderer, Michael Roberts, Nick Roussanov, Anthony Saunders, Carola Schenone, William Schwert (the editor), Lemma Senbet, Clemens Sialm, Nick Souleles, Jason Smith, Anjan Thakor, Sheridan Titman, Heather Tookes, Paolo Volpin, Toni Whited, Jeff Wurgler, an anonymous referee, and the conference and seminar participants at the 2009 AFA meetings, 44th Bank Structure Conference (Chicago Fed), the 2008 EFA meetings, the 3rd FIRS conference (Alaska), the 2008 NBER Summer Institute Corporate Finance Workshop, the NYU Stern Five-Star Conference, the 2nd Risk Management Conference (Singapore), Steve Ross Conference, American University, Georgetown, Georgia Tech, Illinois, INSEAD, NY Fed, Philadelphia Fed, Rutgers, SF Fed, Stockholm School of Economics, Temple, U Arizona, UBC, UC Irvine, UNC, UT Austin, Darden, Washington University (Olin), Wisconsin, and Wharton for helpful comments and discussions. An earlier draft of this paper was titled "The Effects of Bond Supply Uncertainty on the Leverage of the Firm". We gratefully acknowledge financial support from the INSEAD/Wharton Alliance. Yasuda gratefully acknowledges financial support from a Rodney L. White grant and a Morgan Stanley Research Fellowship. All errors and omissions are our own.
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0304-405X/$ - see front matter
http://dx.doi.org/10.1016/j.jfineco.2013.04.011

1. Introduction

In the last decade, bond financing has become one of the most important sources of external financing for (especially large) U.S. corporations. While debt financing has been the dominant source of external financing for U.S. firms for some years,[3] corporate bonds, valued at about $5 trillion in outstanding amount, have accounted for nearly half of the corporate debt raised in the U.S. in recent years. For bond-issuing firms, reliance on bond financing is even greater, with about two-thirds of their total debt being attributable to corporate bonds and less than one-third to bank loans.[4] Institutional investors, such as mutual bond funds and insurance companies, increasingly supply the majority of capital to these firms—either directly through bond financing, or indirectly through investing in securitized loans. Overall, institutional bond investors play an increasingly important role as primary creditors to the firms in the economy. Nevertheless, to the best of our knowledge there is scant evidence on the bond investor base of the firms, that is, on the holders of the firm's bonds and effects their characteristics have on the firm's financing choices. This paper aims to fill that gap using a novel data set that links the individual firm's financing choices and leverage to the characteristics of investors who hold the firm's bonds.

In particular, we analyze the firms' bond investor bases, or clienteles,[5] and investigate whether the capital supply uncertainty of the bond investor bases affects the firm's financing choices and the resulting leverage. The existing literature offers mixed views on the importance of bond investor bases and provides little empirical evidence on their makeup or their actual behavior. Specifically, the theory of the firm's choice between bonds and bank loans often characterizes bond investors as numerous, transient, and having arm's-length transactions with firms that are based on publicly available information, while banks are characterized as having long-term relationships with firms, including access to private information, which lead to their uniqueness as monitors and information producers.[6] In both theoretical and empirical studies,[7] the bond investors are often outside the analysis and are implicitly treated as transient and homogeneous. This view suggests that the firm's bond investor base has no bearing on the firm's bond issuance behavior and, therefore, no bearing on the overall leverage of the firm.

Empirically, however, corporate bonds rarely trade and are extremely illiquid compared to stocks and government bonds.[8] Infrequency of trades suggests that, contrary to the standard treatment in the theory, bond investors may not be all transient investors. Indeed, in practice there is significant heterogeneity among the bond investors. For example, mutual funds (both pure bond funds and blend funds) are subject to market sentiment and tend to experience large fluctuations in their assets under management, as end investors often chase performance and trade in and out of mutual funds frequently with relatively low transaction costs. They are also subject to market-based runs.[9] The credit market turmoil of 2008 shows that runs can happen in bond funds as well. In contrast, insurance companies (pension funds) manage large bond portfolios backing their insurance policies (pension plans) and tend to have a longer horizon. The payouts to their policyholders are highly predicable and smooth, and their assets under management are less volatile and less sensitive to performance. We posit that if investors are non-transient, market frictions exist,[10] and the firms access the bond market regularly — either for refinancing or new financing needs — then the characteristics of the firm's investor base may matter.[11] Firms, aware that high portfolio turnover or flow volatility of their investor bases makes them more prone to credit supply shocks in the future, adjust their choices of financing and leverage policies.

We construct three alternative proxies for the capital supply uncertainty of the firm's bond investor base: (i) the average portfolio turnover, or (ii) the average flow volatility

[3] Rajan and Zingales (1995) report that external financing consisted entirely of debt for U.S. companies in the period 1984–1991, with net equity issuance being slightly negative (due to repurchases).

[4] See Section 3.

[5] Our use of the term "investor base" echoes that of "clientele" in the earlier literature, though our object of study is quite distinct. In the literature on the firm's dividend payout policy (e.g., Elton and Gruber, 1970), the term "clientele effect" refers to that defined by Miller and Modigliani (1961). We eschew the use of the term "clientele" so as to avoid confusion with this literature. Namely, we provide some of the first empirical evidence on the bond investor base, as opposed to the equity investor clientele based on tax rates. More recently, Kim and Stulz (1988) use the term "clientele" in the context of the Eurobond market in the 1980s. Our study is more closely related to their work, with the emphasis on the firm's existing bond investors.

[6] Berlin and Loeys (1988), Diamond (1991), Chemmanur and Fulghieri (1994), and Bolton and Scharfstein (1996). For other works on the determinants of the firm's choice of type of debt, see James (1987), Rajan (1992), Houston and James (1996), Carey, Post, and Sharpe (1998), Cantillo and Wright (2000), Hovakimian, Opler, and Titman (2001), Denis and Mihov (2003), and Gomes and Phillips (2012).

[7] Following these stylized facts emphasized in the theoretical literature, empirical studies such as Puri (1996), Gande, Puri, and Saunders (1999), Yasuda (2005, 2007), Drucker and Puri (2005), and others examine the informational roles of banks as underwriters and find that banks improve their borrowers' access to capital markets by certifying their values as underwriters, especially for informationally opaque issuers. Faulkender and Petersen (2006) argue that the firm's access to bond markets itself is a significant determinant of the firm's leverage.

[8] The daily trading volume for U.S. corporate bonds is about $15 billion, compared to close to $150 billion for U.S. equity. This is despite the larger outstanding size of the corporate bond markets ($6.3 trillion bonds vs. $5.3 trillion equity as of 2008). (*Source*: www.sifma.org) Goldstein, Hotchkiss, and Sirri (2007) also report that the introduction of the Trade Reporting and Compliance Engine (TRACE) in 2002 increased transparency and liquidity but not trading volumes in the corporate bond market.

[9] Bernardo and Welch (2004) argue that any negative impact of runs is exacerbated by investor payoff complementarities, where some investors' decisions to withdraw funds first hurt the payoffs of those investors who remain. For a related empirical study of equity mutual funds, see Chen, Goldstein, and Jiang (2010). See also Diamond and Dybvig (1983) and Morris and Shin (1998).

[10] Leary (2009) and Lemmon and Roberts (2010) provide evidence supportive of debt market segmentation by exploiting aggregate exogenous shocks to bank loan supply and junk bond supply, respectively.

[11] If bond investors are transient and supply adjusts quickly, then the investor base of the firm's outstanding bonds has no bearing on its future financing conditions. Also, if the firms access bond markets very infrequently (e.g., once every 20 years) to meet all their financing needs, then again the current investors' conditions are unlikely to affect future financing decisions.

of investors holding the firm's bonds, or (iii) the prevalence of mutual funds among the firm's bondholders as opposed to insurance companies. We then use these proxies to relate the capital supply uncertainty of the firm's bond investor base to the firm's financing decisions, its overall leverage level, and its maturity choice.

As bond investors are not randomly assigned to firms, overcoming endogeneity is a critical issue in examining these questions. Our key identification strategy is to construct and use geography-based instrumental variables measuring the mutual fund concentration (or average investors' turnover) in the firm's local region. We also show that the results are robust to inclusion of firm fixed effects, which helps strengthen the validity of our instruments. To further rule out any alternative omitted variable explanations, we conduct various subsample analyses based on investor and firm characteristics, and a placebo test.

We provide evidence that the supply uncertainty of the firm's bond investor base is very important in determining the firm's financing decisions and capital structure. First, we find that the supply uncertainty has a negative and significant effect on the firm's probability of issuing bonds while it has positive effects on the firm's probability of issuing equity and borrowing from banks. We argue that firms respond to an increase in the supply uncertainty of their bond investor bases by substituting away from bonds into equity and bank loans. Second, we find that the supply uncertainty of the firm's bond investor base has significant and negative net effects on the leverage in the firm fixed-effects models. This net effect on leverage is quite robust and long lasting.

These first two findings are not only statistically significant but also economically relevant. An increase of one standard deviation in the supply uncertainty reduces (increases) the probability of issuing bonds (equity) by 22% (17%). One standard deviation higher supply uncertainty is related to a reduction in leverage ranging from 1% to 2%. These results hold whether we use market leverage or book leverage as the dependent variable, and whether we use simple or dynamic leverage adjustment models. Furthermore, the results are robust to controlling for the potential endogeneity of the investor-firm matching using geography-based instruments and are in fact strengthened by it.

Third, we show that the impact of supply uncertainty on the firm's financing choices and leverage is entirely driven by firms with highly concentrated bond investor bases. Specifically, we sort firms based on three alternative dimensions measuring the concentration of investor bases — (i) local bias (proximity of investors to firms), (ii) geographic concentration of investors themselves, and (iii) herding propensity of investors — and show that the supply uncertainty has significant effects on financing behavior and leverage only for those firms with investor bases at above-average concentration levels. Our interpretation is that bond financing is an especially unreliable source of financing for the firm when it not only faces investors with high capital supply uncertainty but also a narrow and undiversified pool of potential investors. In contrast, the limiting effect of the capital supply uncertainty is mitigated when the firm's investor base is diversified and the shocks to the investors are not highly correlated.

Finally, we document that the supply uncertainty affects the firms' choice of debt maturity. Firms are more likely to issue long-maturity debt when supply uncertainty among bond investors is high. Moreover, we find that this effect of supply uncertainty on the firm's debt maturity decision is primarily driven by the supply uncertainty in the short-term category.

We are not the first to investigate the role of credit supply and debt market segmentation in capital structure choice. Gan (2007) and Khwaja and Mian (2008) exploit cross-bank variation in exogenous shocks to bank credit supply and examine their effects on lending and firm investments. Similarly, Sufi (2009), Leary (2009), and Lemmon and Roberts (2010), among others, show that one-time aggregate shocks to bank loan or junk bond supply can have a contemporaneous effect on the affected firm's financing choices relative to those of unaffected firms. This paper extends that idea to show that a proxy for the likelihood of *future* supply shocks can affect the firm's current financing decisions. Faulkender and Petersen (2006) show that firms with access to bond markets have significantly higher leverage than firms without such access. Our contribution is to highlight the importance of the supply uncertainty of the firm's bond investor base in affecting the firm's *ease of* access to the bond market.[12]

Our results also have important policy implications. In the wake of the credit market disaster of the fall of 2008, corporations of all sizes and credit quality faced severe credit freezes in both loan and bond markets. This raised fear among even the largest and most solid firms that they would have difficulty completing new debt financing. Our findings suggest that the supply uncertainty of the firm's investor base is an important determinant of the firm's ease of access to the bond market. Namely, our results highlight the fragility of access to the bond market for companies that depend on mutual funds with high turnover/ flow volatility as primary bond investors.[13]

The rest of the paper is organized as follows. Section 2 details our research questions and empirical approach. Section 3 discusses the data and presents summary statistics. Section 4 presents the baseline results for the firm's financing choice and leverage models. Section 5 presents IV model results and other analyses we conduct to address the potential endogeneity issues with the baseline models. Section 6 examines the effect of capital supply uncertainty on debt maturity. Section 7 concludes.

[12] In the behavioral finance literature, Baker and Wurgler (2000, 2002) and others argue that capital structure is the cumulative outcome of a series of financing decisions in which managers take advantage of temporary market misevaluations, while Welch (2004) argues that managers fail to counteract the mechanistic effects of stock returns on their capital structure and therefore capital structure is almost entirely determined by lagged stock returns. These studies focus on the equity/ debt choice, thus not differentiating between distinct sources of debt, such as bank loans and bonds. Also see Ivashina and Sun (2011) and Nini (2008).

[13] Manconi, Massa, and Yasuda (2012) document that high-turnover and high-volatility mutual funds with heavy exposure to securitized bonds sold corporate bond holdings to meet their liquidity needs at the onset of the financial crisis in 2007, thereby inducing the yields of those corporate bonds to widen.

2. Research design

2.1. Hypotheses

Does the capital supply uncertainty of the firm's bond investors affect its corporate finance? We posit three sets of hypotheses regarding this central question. The first set of hypotheses is about the effect of the supply uncertainty on the firm's financing decisions and leverage; the second set is about whether the effect of the supply uncertainty on the firm's choice depends on the concentration of the firm's investor bases; and the third set is about the effects of the supply uncertainty on the firm's choice of debt maturity.

Given that the supply uncertainty of the firm's bond investors would not be a relevant measure of future financing conditions for the firm if it faces a perfectly elastic supply of capital from all (potential) bond investors, the null hypothesis is that the supply uncertainty of the firm's bond investors has no effect on substitution patterns across bond, bank, and equity financing decisions by the firm. This coincides with the standard assumptions made in the theory about transiency and homogeneity of bond investors. We call this the *Uncertainty Irrelevance Hypothesis* (Ho).

If, on the other hand, bond investors are non-transient and heterogeneous, and their supply of capital is not perfectly elastic in the short run, then, all else equal, high capital supply uncertainty of the firm's bond investors makes the bond market less reliable as a funding source. For example, if the firm's bond investors are subject to market-based runs, or if their assets under management are sensitive to performance and therefore volatile, then they are less likely to provide the capital the firm needs in future financing and refinancing events. Moreover, suppose that firms face significant costs in switching capital providers from, say, bonds to bank loans or equity. We hypothesize that this in turn makes the firm rely less on the bond market as a source of external financing, and by the same token rely more on the equity market and the bank loans. We call this the *Security Substitution Hypothesis* (H1a).

On the effect of bond capital supply uncertainty on leverage, we similarly postulate the null and the alternative hypothesis. If bond investors are homogenous (with respect to a given firm) and have perfectly elastic supply of capital, then the supply uncertainty of the firm's bond investor base should not be relevant for the firm's future leverage (*Uncertainty Irrelevance Hypothesis* (Ho)). In contrast, to the extent that firms respond to the rise in the supply uncertainty by substituting between bond, equity, and bank loans, the net effect of supply uncertainty on the firm's leverage should be negative for two reasons. First, the equilibrium level of substitution between bank loans and bonds may be less than perfect. Indeed, on the price side, the literature suggests that bank loans are more expensive than bond financing due to the cost of delegated monitoring (Diamond, 1991). Furthermore, on the quantity side, banks may ration the amount of loans they provide to a given borrower (Petersen and Rajan, 1994). If either mechanism is at work, an increase in the supply uncertainty of the firm's bond investor base may result in less than one-to-one substitution towards loan markets. This would induce a lower leverage. Second, to the extent that firms have relatively cheap access to equity financing, there may be an optimal level of substitution toward equity when the supply uncertainty of the firm's bond investors increases, further reducing the leverage. We call this the *Net Leverage Effect Hypothesis* (H1b). H1a and H1b are thus two tests of the same hypothesis about the supply uncertainty sensitivity of the firm's financing policy.

The effect of the bond capital supply uncertainty on the firm's financing choices and leverage depends on the diversity of the firm's investor base. When is the limiting effect of supply uncertainty particularly costly to the firm? The supply uncertainty of its bond investors exposes the firm to the risk of not being able to raise the funds it needs in the future, thus forcing it to either forgo profitable investment opportunities or, worse, default on outstanding debt and/or go bankrupt. This risk is mitigated to some extent if the shocks to individual institutions among the firm's investor base are not highly correlated. Then, while each investor may be volatile in their potential supply of capital, the firm benefits from diversifying across a pool of investors whose idiosyncratic shocks offset each other in the aggregate. By the same token, the firm's exposure to investors' shocks is costlier when they are highly correlated among the firm's investor base.

This argument predicts that the firm's responsiveness to its investors' supply uncertainty is positively related to the concentration of its bond investor base. Firms with an undiversified pool of investors, whose supply of capital is likely to expand and contract at the same time, are expected to respond to the supply uncertainty of their bond investor bases the most, since they pay the highest cost by exposing themselves to this source of funding shocks. For firms whose investor bases are diffuse, on the other hand, supply uncertainty is not as costly, since one investor's negative shock is likely to be canceled out by another investor's positive shock. We call this the *Mitigating Effect of Diversification Hypothesis* (H2). Note that this hypothesis applies to the supply uncertainty-sensitivity of both financing decisions and leverage.

The third set of hypotheses is related to the maturity structure of the firm's debt. The literature on debt maturity suggests the use of long-term debt as a way to minimize refinancing risk. For example, Barclay and Smith (1995, p. 611) write: "Implicitly, … the cost of rolling short-term debt is greater than the cost of issuing long-term debt. If there were no differential costs of short-term debt, then all firms would prefer short-term debt… The higher costs of short-term debt potentially include: (1) higher out-of-pocket flotation costs, (2) greater opportunity costs of management time in dealing with more frequent debt issues, and (3) ***reinvestment risk and potential costs of illiquidity***…" (emphasis added by the authors).[14] We posit that higher supply uncertainty presents higher refinancing risk for the firms, and therefore firms are more likely to issue long-maturity debt when facing higher supply uncertainty from

[14] See also Almeida, Campello, Laranjeira, and Weisbenner (2011), who exploit the 2007 crisis as an exogenous shock to the firm's debt maturity structure, and show that firms whose long-term debt was largely maturing right after the onset of the crisis cut their investment significantly more than unaffected firms.

bond investors. We call this the *Maturity Substitution Hypothesis* (H3). The null is again the *Uncertainty Irrelevance Hypothesis* (Ho), which predicts that uncertainty about future bond capital supply has no bearing on the maturity of debt issued. Additionally, because the theory of debt maturity emphasizes the refinancing risk of short-term debt, we also measure the credit supply uncertainty of bond investors in short- and long-maturity categories separately and test whether the effect of supply uncertainty on the firm's debt maturity decision is driven by the supply uncertainty in the short-term category.

2.2. Empirical proxies

We now define the proxies we will use to test our hypotheses. The source of the data is described in the next section. We need empirical measures of (1) the capital supply uncertainty of the firm's bond investor base and (2) investor base concentration. We construct three alternative measures of supply uncertainty: (i) the average turnover of the firm's bond investors, (ii) the share of mutual funds among the firm's bond investors, and (iii) the average flow volatility of the firm's bond investors. The first measure is based on turnover, which (inversely) captures the historical trading horizon of investors. Intuitively, long-term horizon investors are more stable in their potential supply of capital, whereas the supply of capital by short-horizon investors tends to fluctuate more due to their active trading styles.[15] High-turnover portfolios are also associated with high sensitivity of flows to performance and to market sentiment, which contributes to short horizon.[16]

Following the literature, we first measure a turnover at the institutional investor level *using all the bonds held by the investor*, not just the bond issued by the firm. We then aggregate the measures thus constructed across *all the investors* who own the firm's bond to arrive at the firm-level measure of its investors' capital supply uncertainty. This two-step construction method alleviates the potential concern that the turnover measure picks up any firm-specific factors that affect the firm's demand for bonds. In other words, it is unlikely that a change in some unobserved characteristics of a single firm has a significant impact on this measure. The mean (median) number of bonds in investors' portfolios is 94 (47); the mean (median) Herfindahl index of investors' portfolios is 8.5% (3.3%). Thus, investors' portfolios are, on average, well diversified and an impact of a single bond is negligible.

In the first step, we calculate for each institutional investor a measure of how frequently he rotates his positions on all the bonds in his portfolio ("churn rate"). It is measured as the aggregate purchases and sales of bonds divided by the average of bond holdings. If we denote by Q_j the set of bonds held by investor j, the churn rate of investor j at quarter t is:

$$CR_{j,t} = \frac{\Sigma_{i=1}^{Q_j} |V_{i,j,t} - V_{i,j,t-1}(1+R_{i,t})|}{\Sigma_{i=1}^{Q_j} (V_{i,j,t} + V_{i,j,t-1})/2}, \tag{1}$$

where $R_{i,t}$ and $V_{i,j,t}$ represent the total return and the par amount of bond i held by investor j at quarter t.[17] In the second step, we use individual investors' churn rates to construct a measure of average turnover of all bond investors for an issuing firm. Let S_i denote the set of investors which own bond i, and let $w_{i,j,t}$ denote the weight of investor j's holding in the total percentage of bond i held by institutional investors at quarter t. The turnover of bond i is the weighted average of the total portfolio churn rates of its investors in the previous four quarters:

$$Turnover_{i,t} = \sum_{j \in S_i} w_{i,j,t} \left(\frac{1}{4} \sum_{r=1}^{4} CR_{j,t-r+1} \right) \tag{2}$$

The second measure of supply uncertainty uses the information on the identity of individual bondholders and captures the prevalence of mutual funds among a given firm's existing bondholders. This is based on the idea that the capital supply uncertainty is related to the institutional arrangements between asset managers and end investors. Stronger withdrawal rights are related to more volatile fund flows and thus, in the equilibrium, to greater supply uncertainty. For example, mutual fund investors have more flexibility and face lesser penalties in withdrawing funds from their accounts compared to insurance contract holders. Also, employee-defined contribution plans usually have a long-term orientation, while retail open-ended mutual funds tend to be more short-term oriented (Jin and Kogan, 2005). Tactical reasons, i.e., frequent money inflows and outflows (Edelen, 1999), also justify a shorter horizon. In unreported analysis, we study the impacts of Hurricane Katrina and the General Motors (GM) downgrade on end-investor withdrawal decisions and confirm that mutual funds' bond portfolios are more sensitive to exogenous shocks than those held by insurance companies and pension funds. On the basis of these considerations, we define the second measure of supply uncertainty as:

$$Mutual\ Fund\ Fraction_{i,t} = \frac{firm\ i's\ bonds\ held\ by\ mutual\ funds_t}{firm\ i's\ bonds\ held\ by\ all\ investors_t}. \tag{3}$$

We calculate the firm's bond investor base volatility, the third measure of capital supply uncertainty, in a two-step construction method as follows: First, for each investor j in quarter t, we measure the quarterly asset flow as the change in j's asset holdings divided by its holdings in the previous quarter. We define the flow volatility of investor j in quarter t as the standard deviation of j's

[15] By definition, a short-term investor buys and sells his investments frequently, while a long-term investor holds his positions unchanged for a longer period of time. This implies that bonds held primarily by short-term investors are more likely to experience higher turnover than bonds held mainly by long-term investors.

[16] Carhart (1997), Barber and Odean (2000), Gaspar, Matos, and Massa (2005), Chen, Harford, and Li (2007), and Derrien, Kecskes, and Thesmar (forthcoming).

[17] In each quarter, we exclude investors entering the sample for the first time, since they will automatically have a churn rate of 2. If the return of a particular bond issue is missing, we replace it with the median return of similar bonds with the same maturity and credit ratings. We also excluded from the sample any bond-quarter observation where the turnover exceeds 2. Such high turnovers are likely to be caused by bonds reaching maturity or experiencing downgrades. If there are multiple outstanding bond issues for a firm in a given quarter, we use the median value to proxy for the firm's general bond investor turnover.

quarterly asset flows in the previous 12 quarters.[18] Then, for each bond i in quarter t, we calculate its investor base volatility as:

$$Volatility_{i,t} = \sum_{j \in S_i} w_{i,j,t}\ Fund\ Flow\ Volatility_{j,t}, \quad (4)$$

where $w_{i,j,t}$ is as defined before.

We use three empirical measures of the concentration of the firm's bond investor base: (i) *Local bias* (proximity of investors to firms), (ii) *Investor herding,* and (iii) *Investor geographical clustering* (concentration). To define *Local bias*, we begin by dividing the 50 U.S. states into seven areas. *Home area raw ownership*$_{i,t}$ is the percentage of firm i's bonds owned by the home area investors (Coval and Moskowitz, 1999, 2001). *Local bias* is defined as the difference between the *Home area raw ownership* and the fraction that *would be* held by home area investors under the assumption that each investor holds the market portfolio. As reported in Table 1, Panel A, home area investors hold on average 33% to 38% of the firm's bonds: the home bias is on average 14% to 15%, and is highly significant. Thus, the ownership of corporate bonds by institutional investors exhibits significant local bias.[19]

To define *Investor herding*, let/($S_{i,t}$) denote the number of investors who buy (sell) bond i at quarter t. Then the herding measure (HM) is expressed as:

$$HM_{i,t} = |p_{i,t} - E[p_{i,t}]| - E|p_{i,t} - E[p_{i,t}]|, \quad (5)$$

where $p_{i,t} = B_{i,t}/(B_{i,t}+S_{i,t})$ is the proportion of all investors trading issue-quarter i, t that are buyers.[20] In Panel B, we report statistics on (i) the degree to which home area investors herd with other home area investors on home area bonds and (ii) the degree to which non-home area investors herd with other non-home area investors on home area bonds. As shown in the first column, home area investors herd with each other (0.172).[21] Non-home area investors also herd with each other (0.129), but home area investors herd significantly more than the non-home area investors. In other words, within each home area, investors herd more when buying and selling their local area bonds.

Investor geographical clustering captures the proximity of institutional bond investors to each other. We apply clustering analysis (Hartigan, 1975) and measure the extent to which investors are concentrated in particular local clusters.[22]

In Panel C, we use these measures of concentration to relate concentration of investor bases to the likelihood of buy–sell trade imbalances. We define the *Buy–sell trade imbalance*$_{i,t}$ for firm i's bond at period t as the difference between the sum of (the absolute values of) net position changes for buyer investors and seller investors divided by the total holdings of the bond by institutional investors. Intuitively, it captures how much net excess buying or net excess selling the firm's bond experiences as a fraction of the total bonds held by institutional investors. We expect that the higher the fraction, the higher the potential gap in capital supply.

The results indicate that the buy–sell trade imbalance is significantly higher when (i) there is more local ownership, (ii) investors are clustered geographically closer, and (iii) investors herd more with each other. These results are consistent with the notion that, for issuers with highly concentrated investor bases, there exist higher correlations of shocks among the investors and a higher chance that the credit provided by their existing investors deviates from the amount that the firm needs at future financing events.

3. The data

Our data come from multiple sources. We construct the proxies for supply uncertainty using Lipper's eMAXX fixed income database. It contains details of fixed income holdings for nearly 20,000 U.S. and European insurance companies, U.S., Canadian, and European mutual funds, and leading U.S. public pension funds. It provides information on quarterly ownership of more than 40,000 fixed-income issuers with $5.4 trillion in total fixed income par amount (both public issues and private placements) from the first quarter of 1998 to the second quarter of 2005. We supplement the Lipper data with bond returns from Bloomberg. We merge the Lipper data set with the Center for Research in Security Prices (CRSP)/Compustat database. We only include firms with complete information on bond turnover and book assets for at least five years during the period from 1998 to 2005. We exclude financial firms with an Standard Industrial Classification (SIC) code between 6000 and 6999, firms with a book asset value of less than $10 million, firms with market-to-book ratio larger than ten, and firms with market leverage or book leverage greater than one. Our primary sample consists of 4,563 firm-year observations.

Our sample of public bond and equity issues is drawn from the SDC global new issues database for the years 1999–2005. We obtain individual loan-transaction data from Loan Pricing Corporation (LPC)'s DealScan database

[18] Before (after) 2001, we impose a minimum of six (ten) quarters of past quarterly asset flows to calculate fund volatility and exclude fund-quarters that do not meet the criteria.

[19] See Massa, Yasuda, and Zhang (2009), Becker (2007), Hong, Kubik, and Stein (2005), and Mian (2006) for related evidence.

[20] The construction of the variable follows Grinblatt, Titman, and Wermers (1995). The first term represents the "extra" portion of investors buying a particular bond issue during a given quarter relative to the expected proportion of buyers. The second term is an adjustment factor allowing for random variation around the expected proportion of buyers under the null hypothesis of cross-sectional independence among trades by institutional investors. Also see Lakonishok, Shleifer, and Vishny (1992) and Wermers (1999).

[21] Note that the degree of herding is measured here for a region (either a home area or a non-home area). Thus, for a given bond, it is possible that investors in a region are net buyers or sellers in a given period, since a buyer in a given trade is not necessarily matched to a seller within the same region.

[22] We take a set of investors investing in a given rating category (e.g., BBB) and partition them into ten clusters based on their geographical distances from each other. For rating category k at quarter t, let $n^k_{m,t}$ be the number of investors within cluster m (m=1,…,10) and $v^k_{m,t}$ be the total holdings value of cluster m investors. Then, the geographical clustering (GC) for bond i that belongs to rating category k at quarter t is defined as $GC_{i,t} = \Sigma^{10}_{m=1}(n^k_{m,t}/\Sigma^{10}_{m=1} n^k_{m,t}) * (v^k_{m,t}/\Sigma^{10}_{m=1} v^k_{m,t})$.

Table 1
Concentration of bond investor bases.

This table presents sample summary statistics on investor base concentration measures. Panel A presents the results on home bias in bond ownership; Panel B presents the results on investor herding of local bonds; and Panel C shows the relationship between investor base concentration measures and capital supply imbalances. A bond i held by investor j is said to be owned by a home area investor if investor j and the issuer of bond i are headquartered in the same region (the U.S. 50 states are divided into seven regions). *Home area rawownership*$_{i,t}$ is the percentage of firm i's bonds owned by the home area investors. *Local bias* is defined as the difference between the *Home area raw ownership* and the fraction that would be held by home area investors under the assumption that each investor holds the market portfolio.Investor herding is defined by Eq. (5) in the text. For each bond we calculate the herding measure separately for home area investors as well as non-home area investors. Holdings are aggregated at the fund family level. Note that, in order to compute these home bias measures in a meaningful way, we need to require that there be at least some minimum number of investors in home areas and non-home areas each holding a given bond. We set this minimum number of investors at ten; results are qualitatively similar for cutoffs at three and five. The number of firm-year observations for each cutoff level appears in parentheses. Panel C presents the univariate test results of the null hypothesis that there is no correlation between the measures of investor base concentrations and the net capital supply imbalances. For each bond i, the buy–sell *Trade imbalance*$_i^t$ is defined as follows:

$$Trade\ Imbalance_i^t = \left| \frac{\Sigma_{j \in B_i^t} |N_{i,j}^t| \Sigma_{j \in S_i^t} - |N_{i,j}^t|}{\Sigma_{j \in All} V_{i,j}^t} \right|,$$

where $V_{i,j}^t$and $N_{i,j}^t$ are the par amount and the net change in the par amount of bond i held by investor j during quarter t, and B_i^t and S_i^t denote the set of investors which are net buyers and sellers of bond i in quarter t, respectively. The number of firm-year observations for each subsample appears in parentheses. The symbols *, **, and *** indicate statistical significance of the test at the 10%, 5%, and 1% level, respectively.

Panel A: Home bias in bond ownership

Minimum number of investors holding each bond	Mean home area raw ownership	Mean local ownership	*t*-Test	Wilcoxon
> =10 Home area investors & > =10 Non-home area investors	37.7% (3,545)	15.3% (3,545)	75.04***	49.74***

Panel B: Investor herding on home area bonds

Minimum number of investors holding each bond	Mean home area investors' herdingmeasure on home area bonds	Mean non-home area investors' herding measure on home area bonds	*t*-Test	Wilcoxon
> =10 Home area investors & > =10 Non-home area investors	0.172 (1,138)	0.129 (1,138)	13.30***	13.02***

Panel C: Investor base concentrations and trade imbalances

	Mean trade imbalance			
Sorting criteria	High (≥median)	Low (< median)	*t*-Test	Wilcoxon
Home area raw ownership	0.209 (2,339)	0.192 (2,224)	1.88*	2.88***
Herding measure (HM)	0.244 (2,299)	0.156 (2,264)	9.70***	10.34***
Geographic clustering (GC)	0.268 (2,315)	0.131 (2,248)	15.27***	18.34***

for the years 1999–2005. We select only completed and confirmed transactions. The majority of these deals consist of term loans and revolving lines (about 75% of the sample). Nearly 20% of the sample is 364-day facilities; importantly, most of them are used to back up the issuance of commercial papers (CP) (i.e., LPC reports the primary purpose of these loans as CP backup).[23]

In merging the Lipper data with the SDC and LPC data, we require the firm-year proceeds to be at least $10 million for each type of financing; if one firm has multiple deals of the same type in a year, we aggregate the issuance amount and treat them as a single observation. This process results in 600 firm-year observations for bonds, 341 firm-year observations for equity issues, and 1,124 firm-year observations for bank borrowing.[24] Using this merged data set we construct a number of firm characteristics (see Appendix A for variable definitions).

Descriptive statistics are reported in Table 2 and Fig. 1. As shown in Table 2, the mean bond turnover is 0.31, which is much lower than the mean stock turnover (0.68). Since the turnover inversely captures horizon, this implies that on average, bond institutional investors are longer-horizon investors than equity institutional investors. While the mean is low, this measure has a much higher standard deviation (0.15) than the stock turnover (0.06).

[23] Banks frequently provide what is known as CP backup lines of credit (Gatev and Strahan, 2006), a form of insurance to CP issuers. These lines of credit are used as liquidity insurance in case the firm is unable to refinance its CP upon maturity and thus serve a very distinct role. We distinguish them from other lines of credit and use only non-CP related lines of credit in our analysis of bank loans.

[24] If the firm taps multiple security types in a given period (e.g., firm A issues a bond *and* borrows from a bank), we count that firm-year as both a bond issuance observation *and* a bank borrowing observation. The results are robust to dropping these firm-years in which the firm taps multiple security types from our analysis; in fact, the results actually become stronger, which is consistent with these observations being noisier ones.

Table 2
Summary statistics.
This table presents summary statistics for the 4,563 firm-year observations in the 1998–2005 period. Variable definitions are provided in the Appendix A.

Variables	Data source	*N*	Mean	Median	Std. dev.
Bond turnover	Lipper/Bloomberg	4,563	0.31	0.26	0.15
Mutual fund fraction	Lipper	4,563	0.30	0.10	0.36
Bond flow	Lipper/Bloomberg	4,563	−0.06	−0.03	0.13
Institutional bond-to-corporate debt ratio	Lipper	4,563	0.33	0.29	0.23
Stock turnover	13F	4,563	0.68	0.68	0.06
Stock flow	13F	4,563	−0.00	−0.00	0.03
Stock holding fraction	13F	4,563	0.48	0.46	0.21
Market leverage	Compustat	4,563	0.33	0.28	0.23
Book leverage	Compustat	4,563	0.32	0.30	0.16
Abnormal return	CRSP	4,563	0.01	0.01	0.39
Amihud'silliquidity	CRSP	4,563	36.05	24.73	36.32
Stock return volatility	CRSP	4,563	0.13	0.11	0.07
Asset tangibility	Compustat	4,563	0.36	0.31	0.23
Assetsize	Compustat	4,563	7.32	7.25	1.56
Profitability	Compustat	4,563	0.12	0.12	0.08
Altman's *Z*-score	Compustat	4,563	1.57	1.59	1.13
Research and development	Compustat	4,563	0.02	0.00	0.04
Capital expenditure	Compustat	4,563	0.02	0.03	0.09
Market-to-book ratio	Compustat	4,563	1.34	1.05	0.98
Asset maturity	Compustat	4,563	13.22	14.15	6.78
Bond maturity (years)	SDC New Issue	947	10.14	10.38	7.44
Bank debt maturity (years)	LPC DealScan	1,309	3.50	3.67	2.01

The standard deviation reported here is for bond-quarters and thus reflects both cross-firm and within-firm (cross-time) variation. The average standard deviation of bond turnover in a cross section (average over time) is 0.14, or 47% of the mean. The average within-firm standard deviation of turnover (average across firms) is 0.06, or 18% of the mean. Thus, cross-section variation is about twice as large as the time-series (within-firm) variation for the turnover measure.[25] In contrast, cross-section variation is nearly four times as large as the time-series (within-firm) variation for the mutual fund fraction measure. Thus, while the three measures of supply uncertainty are related, they are also different in that the variation in the mutual fund fraction measure is mostly cross-section driven, whereas the variation in the turnover (and volatility) measures are driven by both heterogeneity across firms and time-series changes within firms. These distinctions are important when we use geography-based instruments to address endogeneity (Section 5).

Fig. 1(1–1) (1–2) presents the turnover (volatility) by fund type and year. Consistent with our construction of the mutual fund fraction as an alternative measure of the credit supply uncertainty, we find that mutual funds consistently have much higher turnover and volatility than insurance companies. Fig. 1(1–3) further shows that, among the sample investors, insurance companies hold approximately 60% of the par amounts, mutual funds about 30%, and pension funds about 10%. This composition holds relatively steady over time. Fig. 1(1–4) shows that the par amounts of bonds held by the sample institutional investors represent approximately half of the outstanding bonds. Table 2 also shows that the mean institutional bond-to-corporate debt ratio (bonds held by the sample institutional investors divided by *total* corporate debt—the sum of loans and bonds) is 0.33.[26] These two numbers imply that on average, these bond issuers' corporate debt consists of about two-thirds bonds and one-third bank loans. The mean market and book leverage is 0.33 and 0.32, respectively. The mean bond maturity (averaged over

[25] For volatility, our other measure of supply uncertainty, the average standard deviation in a cross section is 0.03, whereas the average within-firm standard deviation is 0.02. So cross-section variation is about 1.5 times as large as the time-series (within-firm) variation.

[26] While a better measure would be the institutional investors' bond holdings divided by the total outstanding bond issue amounts, the latter amount is not available from Compustat. Compustat instead reports the total corporate debt, which we use here as the denominator.

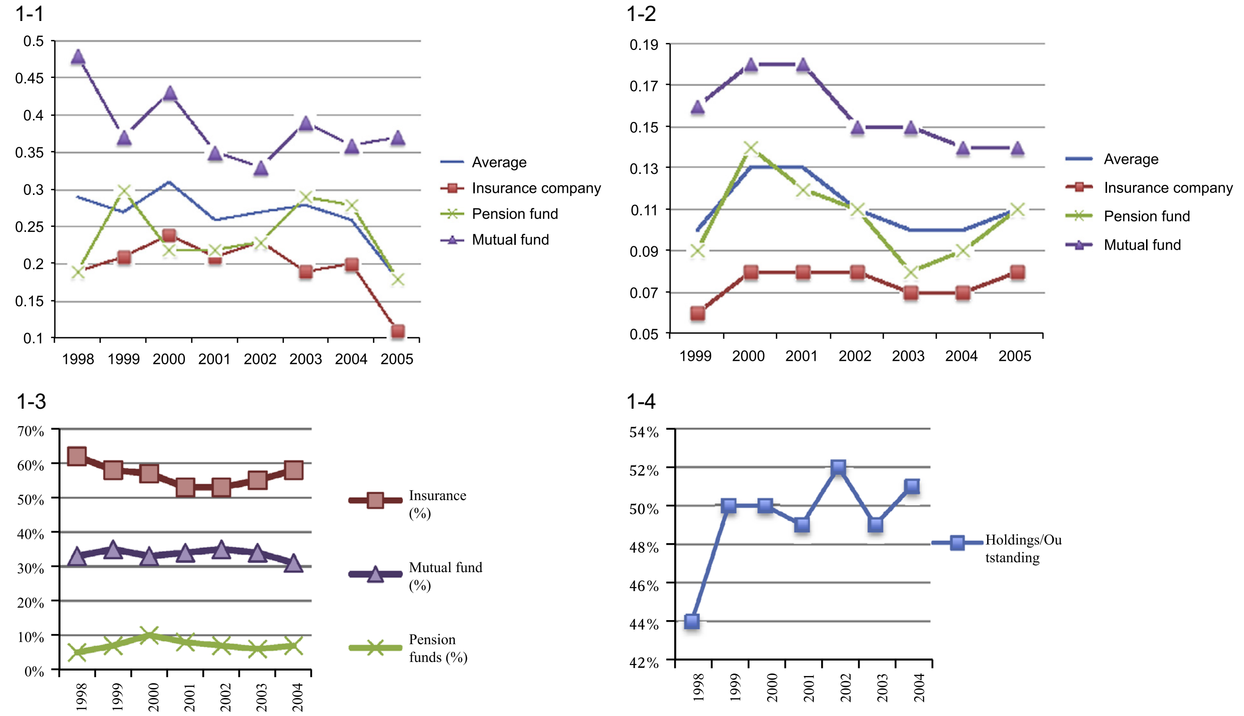

Fig. 1. Summary statistics by fund class and year. The figures present some summary statistics. (1–1) value-weighted average turnover by year and by fund type (insurance companies, mutual funds, and pension funds); (1–2) value-weighted average flow volatility by year and by fund type. Weights used are the funds' holdings for both turnover and flow volatility; (1–3) composition of the bond holdings in the sample by year and by fund type; (1–4) par amount of corporate bonds held by the sample investors as % of the total outstanding amount for the corresponding bonds. See Appendix A for variable definitions.

the 947 bonds in the sample) is 10.14 years, in contrast to the mean bank loan maturity (averaged over the 1,309 bank loans in the sample) of 3.5 years.[27]

4. Baseline estimation results

4.1. The firm's financing choice model

We start our analysis with the firm's financing choice model. To test the *Security Substitution Hypothesis* (H1a), we estimate a series of binary probit models of the firm's issuance choices, examining one security choice at a time.[28] To test the *Mitigating Effect of Diversification Hypotheses* (H2), we split the sample into those with above average and below average levels of (i) local bias, (ii) herding propensity, and (iii) geographic clustering of investors, and estimate the model separately for the six subsamples.

4.1.1. The firm's probability of issuing bonds

We model the firm's decision to issue bonds as a function of the bond turnover (our baseline measure of uncertainty in investors' capital supply) and a set of control variables. The baseline model uses the following probit model specification:

$$\begin{aligned} \text{Bond Issue Choice}_{i,t} = {} & \beta' X_{i,t-1} + \text{turnover}_{i,t-1}\delta_{bond} \\ & + \text{industry dummies}_{j_i}{}'\beta_j \\ & + \text{year dummies}_t{}'\beta_t + \text{credit dummies}_{k_i}{}'\beta_k \\ & + \text{location dummies}_{l_i}{}'\beta_l + \varepsilon_{i,t}, \end{aligned} \tag{6}$$

where the dependent variable is a dummy taking the value of one if the firm is a new bond issuer in year t and zero otherwise. The controls are: *Bond flow*, *institutional bond-to-corporate debt ratio*, *stock turnover*, *stock flow*, *stock holding fraction*, *abnormal return*, *Amihud's illiquidity* (Amihud, 2002), *stock return volatility*, *asset tangibility*, *asset size*, *profitability*, *research and development* (*R&D*) *expenditure*, *Altman's z-score* (Altman, 1969), *asset maturity*, *capital expenditure*, *market-to-book ratio*, and *book leverage*. We also include credit rating dummies, year dummies, two-digit SIC industry dummies, and location dummies.[29] The variables are measured as lagged values from the previous year. For a detailed description of their construction, we refer to the Appendix A.

Eq. (6) represents the baseline model for the firm's bond issuance decisions; for alternative financing decisions, we

[27] The shorter maturity of loans relative to bonds is consistent with previous findings reported in the literature. For example, Guedes and Opler (1996) report that the mean maturity of corporate bonds in their sample is 12 years, and Berger, Espinosa-Vega, Frame, and Miller (2005) report that the mean maturity of loans in their sample is less than two years. Note that the numbers of bond issues and bank loans reported here for the purpose of calculating average maturities are larger than the number of firm-years in which we report positive incidence of bond issuance and bank loans. This is because some firms issue multiple bonds (or receive multiple bank loans) in a given year.

[28] The results are robust to using a multinomial choice model framework. These are available upon request.

[29] We do not include macroeconomic variables in our regressions since they will be captured by the year dummy variables.

replace the dependent variable with the corresponding bank borrowing dummy variable and equity issuance dummy variable.

The bond issuance results are reported in Table 3. Column 1 reports the full sample results; columns 2–7 present the subsample results. All of the specifications include industry dummies, year dummies, location dummies, and credit rating dummies, and the errors are clustered at the firm level.

Several findings are noteworthy. First, the results in column 1 indicate that there is a significantly negative relation between the firm's likelihood to issue bonds and the turnover (our baseline proxy for supply uncertainty) of the firm's bond investors. An increase of one standard deviation in the turnover decreases the probability of issuing bonds by 22%.[30] This supports the *Security Substitution Hypothesis* (H1a) and shows that the high supply uncertainty induces a shift away from bond finance. The signs of the other control variables are as expected: firms that have high stock turnover, high stock return volatility, or high *z*-score (distance from financial distress) are less likely to issue a bond, whereas firms that experience high abnormal return, or have large asset size, high asset tangibility, high capital expenditure, or high book leverage are more likely to tap the bond market. The coefficient on the *Institutional bond-to-corporate debt ratio* is negative and significant.[31]

Second, the results in columns 2–7 indicate that the effect of investor supply uncertainty on the firm's bond issuance choice is driven by firms with highly concentrated investor bases, i.e., firms with high local ownership (column 2), firms whose investors herd more (column 4), and firms whose investors are located close to each other (column 6). These results support the *Mitigating Effect of Diversification Hypothesis* (H2).[32]

4.1.2. The probability of issuing equity

Table 4 presents the results on the firm's choice of issuing equity, for which we used the same model specification and control variables as in the bond issuance model. First, the results reported in column 1 show a significantly positive relation between the decision to issue equity and the supply uncertainty of the firm's bond investors. The turnover coefficient is also economically significant: one standard deviation higher investor turnover is related to a 17% higher probability of issuing equity. Together with the findings in column 1 of Table 3, this supports the *Security Substitution hypothesis* (H1a) and shows that an increase in the bond capital supply uncertainty induces a substitution away from bond finance toward equity finance. The subsample results (columns 2–7) are consistent with H2, i.e., the sensitivity of the firm's financing decisions to the future supply uncertainty is higher for firms with more highly concentrated investor bases.

The signs of the other control variables are as expected: firms that have high stock illiquidity, high profitability (and thus more retained earnings), or long distance to financial distress are less likely to issue equity, whereas firms that experience high stock flow or high abnormal returns, or have large asset size, high capital expenditure, high market-to-book ratio, or high book leverage are more likely to tap the equity market.

4.1.3. The probability of borrowing from banks

We model the firm's choice of borrowing from banks as a function of bond capital supply uncertainty and a set of control variables. The results of the baseline models are reported in Panel A of Table 5. For brevity, only the coefficient of interest, bond investor turnover, is reported; the model specification is the same as those for the bond and equity decisions. In column 1, the coefficient on turnover is not significantly different from zero, indicating that there is no substitution between bonds and bank loans in response to an increase in the bond investor turnover. This specification, however, masks the cross-sectional variations among firms with high and low concentrations in their investor bases. In columns 2–7, we find that the positive effect of turnover on the firm's bank borrowing choice is concentrated in subsamples with (i) high local ownership and (ii) high herding.[33]

In Panel B, we report the results where we exclusively examine the firm's choice to take on term loans. The results are qualitatively similar to those reported in Panel A. In Panel C, we further focus on those cases (firm-years) in which the firm raises debt (i.e., either issues a bond or borrows from a bank) in a given period and examine the firm's choice of public bond versus bank loans. The dependent variable is equal to one if it is a bank loan and zero if it is a bond. The baseline results (column 1) show a significantly positive relationship between turnover and bank borrowing. When we break down the results into the firm's choice between term loans vs. bonds and its choice between lines of credit vs. bonds (columns 2 and 3), we find substitution away from bonds toward bank

[30] The marginal effect (dP/dX) of the turnover on the probability of bond issuance in the probit model is −0.106. Thus, one standard deviation change (0.15 from Table 2) in the variable leads to a decrease in the issuance probability by $-0.106*0.15=-0.0159$ (−1.59%), which accounts for 22% (1.59%/7%) of the predicted probability at the sample mean (7%).

[31] Note that the fewer bank loans the firm has, the larger this measure would be, since its denominator is the firm's total debt outstanding. Thus, it is possible that this measure picks up the amount of slack the firm has in its bank borrowing capacity, thus causing its coefficient to be negative in the bond issuance decision model.

[32] In untabulated analysis, we examine the effects of the turnover on the ex ante yield of seasoned bond offerings (SBOs). We find that the offer yield spreads are significantly higher for firms with high turnover investors, while controlling for the standard bond and firm characteristics including size, maturity, ratings, and leverage. Results are consistent with the view that firms facing investors with high supply uncertainty pay higher issuance cost.

[33] The signs of other control variables (unreported but available upon request) are largely consistent with the theory: firms that experience high stock flow, or that have high R&D expenditures, or long distance to financial distress are less likely to borrow from banks, whereas firms that have large asset size or high profitability are more likely to borrow from banks. The negative and significant coefficient on the R&D expenditure in particular is interesting: one interpretation is that firms that engage

Table 3
Estimation results of the firm's bond issuance choice model.

This table presents the estimation results of the firm's bond issuance choice model. The dependent variable is a binary variable equaling one if the firm is a new bond issuer in a given year and zerootherwise. All the independent variables are defined in the Appendix A. Column 1 presents the baseline model; columns 2–7 present the results of the model for various subsamples. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively, using heteroskedasticity-robust standard errors with t-statistics given in parentheses.

	Full sample	Home area ownership		Investor herding		Geographic clustering	
		High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bond investor turnover	−0.79**	−1.56***	−0.20	−1.17***	−0.44	−1.17**	−0.56
	(−2.56)	(−3.39)	(−0.39)	(−2.82)	(−0.89)	(−2.46)	(−1.25)
Bond flow	−0.20	−0.44	−0.16	0.38	−0.73*	0.18	−0.62*
	(−0.84)	(−1.20)	(−0.45)	(1.07)	(−1.93)	(0.57)	(−1.72)
Bond-to-corporate debt ratio	−0.33**	−0.61***	−0.08	−0.45*	−0.36	−0.41	−0.34
	(−2.06)	(−2.88)	(−0.28)	(−1.92)	(−1.59)	(−1.64)	(−1.60)
Stock turnover	−0.85	−1.89**	−0.46	−1.11	−0.97	−1.23	−0.79
	(−1.40)	(−2.12)	(−0.54)	(−1.21)	(−1.16)	(−1.42)	(−0.88)
Stock flow	0.03	−1.28	1.44	−2.18	1.69	0.17	−0.33
	(0.02)	(−0.45)	(0.63)	(−0.92)	(0.63)	(0.07)	(−0.12)
Stock holding fraction	0.10	−0.20	0.04	0.12	0.09	0.25	−0.15
	(0.52)	(−0.69)	(0.14)	(0.47)	(0.35)	(0.96)	(−0.58)
Abnormal return	0.21**	0.42***	0.11	0.36**	0.09	0.13	0.29**
	(2.33)	(3.14)	(0.82)	(2.58)	(0.72)	(1.03)	(2.26)
Amihud'silliquidity	0.00	0.00	0.00**	0.00	0.00	−0.00	0.00**
	(1.37)	(0.69)	(2.01)	(0.95)	(0.48)	(−1.11)	(2.12)
Stock return volatility	−2.42***	−3.53**	−1.12	−0.61	−3.92***	−0.78	−5.09***
	(−2.97)	(−2.58)	(−1.14)	(−0.63)	(−3.17)	(−0.81)	(−4.05)
Asset tangibility	0.47	−0.68	0.78**	−0.35	1.00***	0.97**	−0.14
	(1.60)	(−1.43)	(2.04)	(−0.82)	(2.88)	(2.42)	(−0.36)
Asset size	0.32***	0.33***	0.30***	0.33***	0.36***	0.30***	0.32***
	(7.40)	(5.40)	(5.23)	(5.30)	(5.50)	(4.80)	(5.22)
Profitability	0.32	0.57	0.26	1.09	0.40	0.87	0.44
	(0.46)	(0.52)	(0.30)	(1.11)	(0.36)	(0.97)	(0.44)
R&D	−1.82	−0.02	−6.79	−1.80	0.19	−0.67	−2.81
	(−1.27)	(−0.02)	(−1.64)	(−0.83)	(0.08)	(−0.32)	(−1.29)
R&D dummy	0.19**	0.19	0.12	0.13	0.29**	0.14	0.20
	(2.04)	(1.47)	(0.81)	(0.92)	(2.19)	(1.10)	(1.42)
Altman's z-score	−0.14**	−0.18**	−0.09	−0.13*	−0.13	−0.05	−0.20**
	(−2.40)	(−1.98)	(−1.17)	(−1.70)	(−1.52)	(−0.59)	(−2.47)
Asset maturity	0.00	0.02**	−0.01	0.01	0.00	−0.00	0.01
	(0.32)	(1.96)	(−0.69)	(0.68)	(0.29)	(−0.39)	(0.70)
Capital expenditure	2.01**	5.66***	1.62	1.57	2.15	−0.59	5.09***
	(2.11)	(3.12)	(1.44)	(1.24)	(1.54)	(−0.49)	(3.64)
Market-to-book	−0.01	−0.02	−0.08	−0.01	−0.04	0.02	−0.07
	(−0.36)	(−0.38)	(−1.60)	(−0.23)	(−0.71)	(0.66)	(−1.23)
Book leverage	0.50*	−0.10	1.00**	0.76**	0.27	0.83**	0.36
	(1.67)	(−0.23)	(2.24)	(2.06)	(0.55)	(2.13)	(0.79)
Year, location, industry,& ratings dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering at	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Pseudo R-squared	0.2465	0.2683	0.2999	0.2678	0.2697	0.2489	0.2464
Number of observations	4563	2266	2297	2299	2263	2315	2248

borrowing in both cases, though the coefficient is larger with term loans than with lines of credit.[34]

In general, bonds are issued at longer maturities than bank loans. In order to make bank borrowing and bond issuing more comparable, we consider an alternative specification where the dependent variable is a dummy taking a value of one if the firm is borrowing from a bank with debt maturity longer than three years and zero if the firm issues a bond with maturity longer than three years.

(*footnote continued*)
heavily in R&D are risky firms that prefer arm's-length financing to bank financing (e.g., Rajan, 1992).

[34] The signs of the control variables (unreported) are interesting. Larger firms are more likely to issue bonds than to borrow from banks, which is consistent with Diamond (1991) who argues that firms with higher reputation and longer credit history (both of which are picked up by the firm size) do not need bank monitoring and prefer cheaper bond finance. High R&D firms are more likely to issue bonds than to borrow from banks, which is again consistent with Rajan (1992). Firms with high

(*footnote continued*)
stock return volatility are less likely to issue bonds than to borrow from banks, which is consistent with the negative coefficient on stock return volatility in the bond issuance choice model in Table 3.

Table 4
Estimation results of the firm's equity issuance choice model.

This table presents the estimation results of the firm's equity issuance choice model. The dependent variable is a binary variable equaling one if the firm is a new bond issuer in a given year and zero otherwise. All the independent variables are defined in the Appendix A. Column 1 presents the baseline model; columns 2–7 present the results of the model for various subsamples. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively, using heteroskedasticity-robust standard errors with t-statistics given in parentheses.

	Full sample	Home area ownership		Investor herding		Geographic clustering	
		High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bond investor turnover	0.55**	0.87**	0.03	0.87**	0.10	0.66**	0.28
	(2.12)	(2.36)	(0.08)	(2.54)	(0.23)	(2.10)	(0.52)
Bond flow	0.20	0.22	0.32	0.65**	−0.33	0.22	0.27
	(1.03)	(0.73)	(1.13)	(2.36)	(−0.98)	(0.97)	(0.65)
Bond-to-corporate debt ratio	−0.32*	−0.75***	−0.08	−0.13	−0.69**	−0.13	−0.56*
	(−1.82)	(−2.80)	(−0.35)	(−0.53)	(−2.43)	(−0.59)	(−1.86)
Stock turnover	0.83	0.82	0.79	−0.79	2.72**	1.06	0.68
	(1.11)	(0.85)	(0.65)	(−0.79)	(2.43)	(1.05)	(0.59)
Stock flow	2.37	0.11	4.29**	2.32	2.93	2.81	1.72
	(1.42)	(0.04)	(2.02)	(1.02)	(1.13)	(1.44)	(0.48)
Stock holding fraction	−0.06	−0.36	−0.01	0.27	−0.15	0.09	−0.21
	(−0.33)	(−1.34)	(−0.05)	(1.11)	(−0.57)	(0.40)	(−0.69)
Abnormal return	0.38***	0.53***	0.29***	0.46***	0.37***	0.36***	0.49***
	(4.97)	(4.30)	(2.76)	(4.48)	(2.76)	(3.97)	(2.96)
Amihud'silliquidity	−0.00***	−0.01***	−0.00**	−0.01**	−0.01***	−0.00	−0.01***
	(−3.45)	(−3.49)	(−2.15)	(−2.60)	(−3.26)	(−1.42)	(−3.93)
Stock return volatility	−0.44	−1.45*	0.55	0.98	−2.00**	−0.28	−1.19
	(−0.82)	(−1.87)	(0.71)	(1.36)	(−2.32)	(−0.42)	(−1.08)
Asset tangibility	−0.03	−0.16	0.31	−0.36	0.14	0.41	−0.55
	(−0.12)	(−0.38)	(0.98)	(−1.00)	(0.37)	(1.37)	(−1.26)
Assetsize	0.07**	0.13**	0.05	0.07	0.13**	0.04	0.15**
	(2.01)	(2.58)	(0.90)	(1.33)	(2.26)	(0.85)	(2.60)
Profitability	−1.18**	−3.51***	−0.27	−1.42*	−0.60	−0.92	−2.63**
	(−2.20)	(−4.12)	(−0.44)	(−1.73)	(−0.74)	(−1.54)	(−2.29)
R&D	−0.10	0.34	−1.33	−0.14	1.04	0.82	−4.51*
	(−0.11)	(0.29)	(−0.76)	(−0.13)	(0.51)	(0.81)	(−1.89)
R&D dummy	0.19**	0.01	0.39***	0.12	0.38***	0.22*	0.19
	(1.98)	(0.05)	(3.02)	(0.94)	(2.72)	(1.83)	(1.32)
Altman's z-score	−0.14***	0.01	−0.17**	−0.08	−0.21**	−0.10	−0.19**
	(−2.83)	(0.11)	(−2.56)	(−1.14)	(−2.51)	(−1.56)	(−2.20)
Asset maturity	0.00	0.01	−0.01	−0.00	0.00	−0.01	0.02
	(0.17)	(1.48)	(−1.06)	(−0.33)	(0.07)	(−0.83)	(1.63)
Capital expenditure	1.62*	−0.08	1.77	2.61**	0.75	0.99	2.68
	(1.83)	(−0.05)	(1.64)	(2.01)	(0.63)	(0.96)	(1.65)
Market-to-book	0.12***	0.12***	0.12***	0.11***	0.13**	0.09***	0.22***
	(4.20)	(3.08)	(2.83)	(3.52)	(2.05)	(2.93)	(3.83)
Book leverage	0.65***	0.81**	0.52	0.99***	0.47	0.66**	0.83*
	(2.68)	(2.30)	(1.41)	(2.98)	(1.11)	(2.17)	(1.95)
Year, location, industry,& ratings dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering at	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Pseudo R-squared	0.1449	0.1947	0.1621	0.1771	0.2049	0.1368	0.2224
Number of Observations	4563	2266	2297	2299	2263	2315	2248

The results are reported in columns 4–6 of Panel C. They show a stronger positive relationship between the probability of bank borrowing and the turnover measure in the bond market. In particular, one standard deviation increase in turnover raises the probability of borrowing from banks by 9%. Taken together, the results in Panel C suggest that firms prefer to substitute for bonds with loans of similar maturity.

To conclude, the overall results reported in Table 5 strongly support the *Security Substitution Hypothesis* (H1a) *and* the *Mitigating Effect of Diversification Hypothesis* (H2): There is substitutability between bond and bank loans, and the effect of supply uncertainty is driven by firms with highly concentrated investor bases.

4.2. *The firm's capital structure*

Having examined in detail the effects of supply uncertainty on the firm's financing decisions, we now turn to our second central question, i.e., the net effect of bond capital supply uncertainty on the firm's leverage. We examine the determinants of the firm's leverage using a firm fixed-effects regression approach. Following the literature, we consider both static and dynamic leverage specifications.

Table 5
Estimation results of the firm's bank borrowing choice model.

This table presents the estimation results of the firm's bank borrowing choice model. Panel A reports the results of the baseline model. The dependent variable is a binary variable equaling one if the firm borrows from a bank in a given year and zero otherwise. In Panel B the dependent variable is a binary variable equaling one if the firm takes a term loan from a bank during a given year and zero otherwise. Panel C presents the results of the firm's bank loan vs. bond debt choice model conditional on issuing debt. In column 1, conditioning on issuing debt, the dependent variable takes a value of one if the firm borrows from banks (either in the form of a term loan or a line of credit) and zero if it issues a bond. In column2, conditioning on either taking a term loan or issuing a bond, the dependent variable takes a value of one if the firm takes a term loan from banks and zero if it issues a bond. In column 3, conditioning on either taking a line of credit or issuing a bond, the dependent variable takes a value of one if the firm takes a line of credit from banks and zero if it issues a bond. Columns 4–6 are defined similarly but for bank loans and bonds with maturities longer than threeyears. To address the potential self-selection issue, we run a first-stage probit regression (unreported) where the dependent variable equals one if the firm issues debt and zero otherwise and include the corresponding inverse Mills' ratio in the second-stage regression. All of the specifications include year-, industry-, location-, and credit rating dummies. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively, using heteroskedasticity-robust standard errors with *t*-statistics given in parentheses.

Panel A: Full-sample baseline model

	Full sample	Home area ownership		Investor herding		Geographic clustering	
		High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bond investor turnover	0.31	0.46*	0.14	0.54**	−0.26	0.27	0.09
	(1.47)	(1.68)	(0.46)	(2.14)	(−0.70)	(1.07)	(0.24)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering at	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Pseudo R-squared	0.12	0.11	0.18	0.11	0.13	0.12	0.14
Number of observations	4,563	2,266	2,297	2,299	2,263	2,315	2,248

Panel B: Term loan choice model

	Full sample	Home area ownership		Investor herding		Geographic clustering	
		High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bond investor turnover	0.42*	0.86***	−0.57	0.67**	−0.16	0.49*	−0.37
	(1.68)	(2.75)	(−1.45)	(2.20)	(−0.42)	(1.69)	(−0.80)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering at	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Pseudo R-squared	0.1236	0.1474	0.1568	0.1554	0.1447	0.1313	0.1630
Number of observations	4,563	2,266	2,297	2,299	2,263	2,315	2,248

Panel C: Bank loan vs. bond choice model

	Bank/bond choice			Bank/bond choice: Conditioning on maturity		
	Bank/bond	Term/bond	Line/bond	Bank/bond	Term/bond	Line/bond
	(1)	(2)	(3)	(4)	(5)	(6)
Bond investor turnover	1.08**	1.38**	0.83*	1.26**	1.54**	1.07**
	(2.22)	(2.17)	(1.75)	(2.47)	(2.25)	(2.05)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Clustering at	Firm	Firm	Firm	Firm	Firm	Firm
Pseudo R-squared	0.3462	0.4464	0.3396	0.2398	0.4751	0.2335
Number of observations	1225	860	1178	1033	805	988

4.2.1. *The (static) effect of supply uncertainty on leverage*

We start with the static leverage specification. The baseline model is:

$$\begin{aligned}\text{Leverage}_{i,t} &= \alpha_i + \beta' X_{i,t-1} + \text{turnover}_{i,t-1}\delta_{leverage}\\ &+\text{industry dummies}_{j_i}{}'\beta_j\\ &+\text{year dummies}_t{}'\beta_t + \text{credit dummies}_{k_i}{}'\beta_k\\ &+\text{location dummies}_{l_i}{}'\beta_l + \varepsilon_{i,t},\end{aligned} \tag{7}$$

where $Leverage_{i,t}$ is a measure of firm i's leverage at period t; α_i is the firm fixed effect; and $X_{i,t-1}$, [35] $turnover_{i,t-1}$, and the various dummy variables are as defined before. We examine both book leverage and market leverage and focus on coefficient $\delta_{leverage}$ in Eq. (7).

[35] While we include the firm's own leverage at $t-1$ as a control variable in discrete-choice models (Eq. (6), reported in Tables 3–5), we include the industry-average leverage as a control variable in estimating Eq. (7), as reported in Table 6.

Table 6
Estimation results of the firm's leverage.

Panel A reports the firmfixed-effects model estimation results of the firm's leverage. All the independent variables are defined in the Appendix A. Column 1 presents the full sample results; columns 2–7 present the subsample results. Panel B presents the estimation results of an alternative leverage model where the external finance-weighted turnover measure is used as the key variable of interest. The EF (external-financing-weighted) turnover is defined as:

$$EFTurnover_{i,t} = \sum_{s=0}^{t} \frac{e_s + d_s}{\Sigma_{r=0}^{t}(e_r + d_r)} Turnover_{i,s}$$

where e_s and d_s denote net equity and net debt issues during year *s*. Net debt issue is the change in book assets minus the change in book equity divided by book assets. Net equity issue is the change in book equity minus the change in retained earnings divided by book assets. All the independent variables, including *EFTurnover*, are lagged values measured in the previous year; their definitions are found in the Appendix A. Column 1 presents the full sample results; columns 2–7 present the results of the model for various subsamples. All of the specifications include year dummies, location dummies, and credit rating dummies. Panel C presents the firm fixed-effects model estimation results of the change in leverage on the target leverage adjustments and the shock to the firm's bond turnover in the bond market. The dependent variable is the change in market leverage, $L_t – L_{t-1}$, from year *t*-1 to year *t*. *Turnover shock* is defined as$Turnover_{t-1} – E(Turnover_{t-1})$ where$E(Turnover_{t-1})$ is estimated as the fitted value of the firm fixed-effects model estimation results (unreported) of turnover on its lagged value and the set of control variables used in the main specification (e.g., Table 6, Panel A). The *Target (leverage) adjustment*$_{i,t}$ is defined as the difference between the leverage at time *t*–1 and the expected level of leverage at time *t*. The expected level of leverage is constructed as the fitted value of the firm fixed-effects model estimation results (unreported) of leverage on the control variables used in the main specification. Column 1 is based on the full sample. Columns 2–7 present the results of the model for various subsamples. All of the specifications include year dummies, location dummies and credit rating dummies. Standard errors are heteroskedasticity-robust and adjusted for estimation errors using bootstrapping procedures. The symbols *, **, and *** indicate statistical significance of the test that the coefficient is different from zero at the 10%, 5%, and 1% level, respectively.

Panel A: Baseline model

	Full sample	Home area ownership		Investor herding		Geographic clustering	
		High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Bond investor turnover	−0.09***	−0.10***	−0.06	−0.12***	−0.05	−0.09***	−0.09**
	(−3.55)	(−2.92)	(−1.55)	(−3.46)	(−1.29)	(−2.73)	(−2.20)
Bond flow	0.03*	0.04	0.03	0.01	0.04*	0.05**	−0.01
	(1.95)	(1.58)	(1.56)	(0.74)	(1.72)	(2.43)	(−0.35)
Bond-to-corporate debt ratio	−0.01	−0.02	−0.01	−0.02	0.00	−0.03	−0.00
	(−0.72)	(−0.70)	(−0.40)	(−0.90)	(−0.01)	(−0.93)	(−0.07)
Stock turnover	−0.05	−0.10	−0.04	−0.03	−0.08	−0.09	−0.06
	(−1.04)	(−1.47)	(−0.48)	(−0.45)	(−1.11)	(−1.18)	(−0.85)
Stock flow	−0.30***	−0.19	−0.37**	−0.32*	−0.29*	−0.29*	−0.24
	(−2.65)	(−1.26)	(−2.22)	(−1.95)	(−1.72)	(−1.80)	(−1.66)
Stock holding fraction	0.05***	0.05**	0.05**	0.04*	0.07***	0.08***	0.02
	(3.16)	(2.07)	(2.32)	(1.67)	(3.00)	(3.12)	(0.95)
Abnormal return	−0.05***	−0.06***	−0.04***	−0.05***	−0.04***	−0.04***	−0.05***
	(−7.52)	(−6.50)	(−4.37)	(−6.26)	(−3.98)	(−4.91)	(−5.91)
Amihud'silliquidity	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(−0.32)	(−0.46)	(0.24)	(0.39)	(0.04)	(−0.71)	(−0.65)
Stock return volatility	0.04	0.16*	−0.11	0.03	0.04	−0.06	0.11
	(0.55)	(1.88)	(−1.12)	(0.29)	(0.37)	(−0.81)	(1.02)
Asset tangibility	0.10*	0.03	0.10	0.08	0.05	0.04	0.15*
	(1.80)	(0.39)	(1.29)	(1.02)	(0.65)	(0.51)	(1.72)
Assetsize	0.04***	0.01	0.06***	0.02	0.06***	0.03	0.05***
	(2.77)	(0.61)	(3.99)	(0.94)	(4.22)	(1.61)	(2.83)
Profitability	−0.23***	−0.34***	−0.12	−0.17*	−0.29***	−0.12	−0.36***
	(−3.26)	(−3.14)	(−1.23)	(−1.74)	(−2.82)	(−1.26)	(−3.28)
R&D	−0.17	−0.14	0.03	−0.17	−0.10	−0.07	−0.46
	(−1.07)	(−0.68)	(0.12)	(−1.09)	(−0.25)	(−0.53)	(−1.61)
R&D dummy	−0.03	−0.00	−0.05**	−0.01	−0.04*	−0.03	−0.03
	(−1.37)	(−0.02)	(−2.18)	(−0.32)	(−1.71)	(−0.98)	(−1.23)
Altman's *z*-score	−0.02**	−0.00	−0.04***	−0.02*	−0.01	−0.02	−0.02
	(−2.30)	(−0.32)	(−2.95)	(−1.67)	(−1.12)	(−1.64)	(−1.66)
Asset maturity	0.00	−0.00*	0.00	−0.00	0.00	0.00	0.00
	(−0.39)	(−1.85)	(0.83)	(−0.68)	(0.34)	(−0.19)	(−0.36)
Capital expenditure	−0.04	0.09	−0.10	−0.01	−0.02	−0.11	0.05
	(−0.48)	(0.64)	(−0.98)	(−0.09)	(−0.22)	(−1.00)	(0.47)
Market-to-book	−0.01**	−0.01	−0.01*	−0.00	−0.02***	−0.01	−0.01*
	(−2.02)	(−1.58)	(−1.86)	(−1.23)	(−2.94)	(−1.39)	(−1.82)
Industry book leverage	0.17***	0.12**	0.20***	0.15**	0.16***	0.15**	0.15**
	(4.15)	(2.06)	(3.54)	(2.49)	(2.72)	(2.58)	(2.56)
Year, location, industry,& ratings dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering at	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Pseudo *R*-squared	0.8067	0.8265	0.7937	0.8185	0.8038	0.7820	0.8434
Number of Observations	4563	2266	2297	2299	2263	2315	2248

Panel B: Modified model with the EF turnover

	Full sample	Home area ownership		Investor herding		Geographic clustering	
		High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
EF turnover	−0.14***	−0.12**	−0.12**	−0.18***	−0.09	−0.18***	−0.09
	(−3.44)	(−2.25)	(−1.98)	(−3.03)	(−1.55)	(−3.25)	(−1.34)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year&location&ratingdum.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering at	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Pseudo *R*-squared	0.8068	0.8260	0.7941	0.8184	0.8040	0.7830	0.8429
Number of observations	4,563	2,266	2,297	2,299	2,263	2,315	2,248

Panel C: Dynamic adjustment model

	Full sample	Home area ownership		Investor herding		Geographic clustering	
Independent Variables		High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Turnovershock	−0.07***	−0.09***	−0.03*	−0.10***	−0.02	−0.06**	−0.07**
	(−3.62)	(−2.75)	(−1.77)	(−4.54)	(−1.13)	(−2.43)	(−2.23)
Target adjustments	0.75***	0.81***	0.72***	0.78***	0.75***	0.81***	0.71***
	(32.37)	(21.14)	(20.57)	(23.43)	(20.50)	(23.44)	(15.56)
Intercept	0.05	0.01	−0.03	−0.01	0.05***	0.10**	0.05
	(0.79)	(0.40)	(−0.99)	(−0.31)	(2.78)	(2.17)	(1.25)
Year&location&ratingdum.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clustering at	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Pseudo *R*-squared	0.3488	0.4008	0.3058	0.3706	0.3443	0.3641	0.3492
Number of observations	4,563	2,266	2,297	2,299	2,263	2,315	2,248

The results are reported in Table 6, Panel A. For brevity we report only market leverage.[36] We find a statistically significant negative link between leverage and turnover. That is, firms facing higher turnover have lower leverage. The results are also economically significant: One standard deviation increase in turnover results in a 1.6% decrease in leverage.[37] Moreover, the impact of supply uncertainty is stronger in subsamples with (i) higher local ownership and (ii) higher herding, while the results do not differ strongly between high- and low-investor geographical clustering. Broadly, these results are consistent with both the *Net Leverage Effect Hypothesis* (H1b) and the *Mitigating Effect of Diversification Hypothesis* (H2).

While these results are in line with our predictions, the model used may not capture the full impact of supply uncertainty, because the model assumes that the firm fully adjusts each period to the fluctuations in its bond investors' turnover. Instead, today's leverage may be the result of a series of past decisions in which the past levels of turnover played a role. Therefore, following Baker and Wurgler (2002), we define an external finance-weighted turnover that allows us to account for the past cumulative effects of supply uncertainty on the current leverage. For firm i, External finance-weighted bond turnover ($EFTurnover_{i,t}$) is:

$$EFTurnover_{i,t} = \sum_{s=0}^{t} \frac{e_s + d_s}{\Sigma_{r=0}^{t}(e_r + d_r)} Turnover_{i,s}, \tag{8}$$

where e_s and d_s denote net equity and net debt issues during year s. Net debt issue is the change in book assets minus the change in book equity divided by book assets. Net equity issue is the change in book equity minus the change in retained earnings divided by book assets. $Turnover_{i,s}$ is the turnover during year s. We then use the lagged value of *EFTurnover* in our second specification.

We report the results in Table 6, Panel B. As before, for brevity we report only market leverage.[38] We find a negative relation between current leverage and *EFTurnover*. Thus, today's leverage is a function of the bond and equity market conditions in the past. Firms that have experienced periods of high turnover in the bond market in the past have a relatively low leverage today. The result is not only statistically significant, but also economically relevant. An increase of one standard deviation in our measure of external finance-weighted turnover reduces

[36] The results using book leverage are qualitatively similar and available upon request.

[37] Because there are firm fixed effects in the leverage models, we use the average within-firm standard deviation, which is 0.057, to gauge economic significance. For example, one standard deviation increase leads to −0.09 × 0.057 = −0.5% absolute reduction in leverage. Since the sample mean leverage is 33%, this translates to 0.51%/33% = 1.55% reduction relative to the sample mean.

[38] The results with book leverage are consistent and available upon request.

leverage by 1.3%. Moreover, the impact of *EFTurnover* is concentrated in subsamples with (i) high herding and (ii) high investor geographical clustering, while the results do not differ strongly between high- and low-local ownership subsamples.[39]

4.2.2. The dynamic impact of supply uncertainty on leverage

One concern with the above model is that firms may adjust leverage dynamically.[40] To address this concern, we also estimate the firm's dynamic leverage adjustment model. In particular, we estimate a firm fixed-effects regression of the change in market (book) leverage on the target market (book) leverage adjustments and the shocks to the firm's turnover. The goal is to focus explicitly on the adjustment that the firm makes in response to the innovations in turnover.[41] We therefore estimate:

$$\begin{aligned} \textit{Change in leverage}_{i,t} &= \alpha_i + \textit{Target leverage adjustment}_{i,t}\omega \\ &+ \textit{Turnover shock}_{i,t-1}\delta_{leverage} + \textit{industry dummies}_{j_i}{}'\beta_j \\ &+ \textit{year dummies}_t{}'\beta_t + \textit{credit dummies}_{k_i}{}'\beta_k \\ &+ \textit{location dummies}_{l_i}{}'\beta_l + \varepsilon_{i,t}, \end{aligned} \tag{9}$$

where *Change in leverage*$_{i,t}$ is firm *i*'s change in leverage from period $t-1$ to t; our key variable of interest, *Turnover shock*$_{i,t}$ is the unexpected component of turnover (defined as the difference between the predicted and actual turnover at $t-1$);[42] *Target leverage adjustment*$_{i,t}$ is the predicted adjustment in leverage (defined as the difference between the expected level of leverage at t and the actual level of leverage at $t-1$).[43] The other indicator variables are as defined previously. Since the second-stage model involves generated regressors, we adjust the standard errors using bootstrapping procedures.

We report the results in Table 6, Panel C. As before, for brevity we report only market leverage. The results using book leverage are consistent. The results show that a positive shock to turnover reduces leverage.[44] A shock equivalent to one standard deviation increase in (unexpected) turnover reduces the leverage by 1%.[45] As expected, the sign on the target adjustment is positive and significant. Taken together, the results indicate that, over and above the usual dynamic adjustments firms make in order to move toward the target level of leverage, firms also adjust their current leverage levels in response to unexpected changes in bond capital supply uncertainty. Furthermore, the impact of supply uncertainty is concentrated in subsamples with (i) high local ownership and (ii) high herding, while the results do not differ strongly between high- and low-investor geographic clustering subsamples. Taken together, these results provide further evidence in support of the hypotheses H1b and H2.

4.3. Results with an alternative measure of supply uncertainty

We now check the robustness of our central findings by replicating the analyses of Sections 4.1 and 4.2 using the *Mutual fund fraction*, an alternative measure of capital supply uncertainty. Estimation results of the firm's financing choice and leverage models are presented in Table 7. For brevity, only the coefficients and *t*-statistics (in parentheses) for the variable of interest, *Mutual fund fraction* (and its variants), are reported. Though unreported, all the

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[39] The signs of other control variables (unreported in the case of Panel B and available upon request) in the (static) leverage regressions are qualitatively similar across different specifications (Panels A and B) and are largely as expected. Consistent with firms taking advantage of buoyant stock market conditions by issuing new equity, firms with high levels of stock flow or high abnormal returns have lower leverage, all else equal. Consistent with high profitability causing the market value of stock to rise, firms with high profitability have lower market leverage, but not lower book leverage. Firms with greater distance to financial distress (as measured by Altman's *z*-score) have lower leverage. Also, larger firms and firms with a high institutional holding ratio in the stock market have higher leverage. These firm characteristics may proxy for firm risk (or lack thereof). Finally, firms that belong to industries with high leverage (not surprisingly) have higher leverage, all else equal.

[40] See, for example, Leary and Roberts (2005), Hennessy and Whited (2005), Flannery and Rangan (2006), and Huang and Ritter (2009).

[41] We note that the role of the turnover shock in Eq. (9) is analogous to other variables that induce the firm to deviate from its target leverage. As discussed in Hovakimian, Opler, and Titman (2001) and Parsons and Titman (2008), some firm characteristics, such as stock returns and book-to-market ratios, can be thought of as determinants for both the target leverage and the deviation between the target and the actual leverage. Similarly, while we postulate that larger than expected supply uncertainty (what we capture as the turnover shock) induces firms to temporarily deviate from its target leverage, it is also plausible that, in response to a high level of supply uncertainty, firms choose lower target leverage ex ante. To ensure the robustness of our finding, we repeat the dynamic leverage adjustment model analysis with and without turnover in the (unreported) target leverage estimation and confirm that our results with respect to the turnover shock in Eq. (9) (as reported in Table 6, Panel C) remain qualitatively the same. Similarly, Hovakimian, Opler, and Titman (2001) include book-to-market ratios and stock returns as explanatory variables for deviations from target, and show that their results are qualitatively the same when they estimate the target leverage with and without these variables as explanatory variables.

[42] The expected level of turnover is estimated as the fitted value of a firm fixed-effects regression (unreported) of turnover on its previous value and the set of control variables used in the main specification (e.g., Eq. (7)).

[43] The expected level of leverage is constructed as the fitted value of a firm fixed-effects regression (unreported) of leverage on the control variables used in the main specification. The results reported in Table 6, Panel C remain qualitatively unchanged when we construct the expected leverage as the fitted value of a firm fixed-effects regression of leverage on the turnover variable and the control variables used in the main specification.

[44] In an unreported analysis, we also estimate the dynamic adjustment model using a system GMM estimation method (Blundell and Bond, 1998). This methodology "is specifically designed to address the econometric concerns associated with estimating dynamic panel data models in the presence of firm fixed effects" (Lemmon, Roberts, and Zender, 2008, p. 1601). We find that the coefficient for the variable of our interest, namely turnover shock, remains negative and significant in the GMM results. The GMM estimate for the target adjustments (speed of adjustment) remains positive and significant but is smaller than the firm fixed-effects estimate, which is consistent with prior results (e.g., see Lemmon, Roberts, and Zender, 2008), p. 1599, Table VI). Therefore, these GMM results further confirm the robustness of our finding concerning supply uncertainty. We refer to Flannery and Rangan (2006) and Huang and Ritter (2009) for discussions of econometric issues with respect to estimation of dynamic adjustment models.

[45] Since this is a firm fixed-effects model, we use the standard deviation of within-firm variation in shocks to turnover, which is 0.037. $0.037*-0.07=-0.26\%$ (or $0.037*-0.05=-0.19\%$), i.e., a standard deviation increase in the shocks to turnover lowers the *change* in market (book) leverage by −0.26% (−0.19%). Since the average market (book) leverage is 33% (32%), −0.26% (−0.19%) accounts for 1% (1%) of the mean leverage.

Table 7
Results with an alternative measure of supply uncertainty.

This table presents estimation results of the financing choice and leverage models with an alternative measure of supply uncertainty. The variable *Mutual fund fraction*$_{i,t}$ is defined as: (the fraction of firm *i*'s bonds owned by mutual funds)/(the fraction of firm *i*'s bonds owned by mutual funds+the fraction of firm *i*'s bonds owned by insurance companies+the fraction of firm *i*'s bonds owned by pension funds) (all in period *t*). The lagged value of this variable is included as a measure of supply uncertainty. For brevity, only the coefficients and *t*-statistics (in parentheses) for the variable of interest, *Mutual fund fraction*, are reported. Though unreported, all the other independent variables included in the baseline models (as in Tables 3–5) are also included in the estimations. The symbols *, **, and *** indicate statistical significance of the test that the coefficient is different from zero at the 10%, 5%, and 1% level, respectively.

	Full sample	Home area ownership		Investor herding		Geographic clustering	
Independent variables		High	Low	High	Low	High	Low
Panel A: Financing choice models	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A–1: Bond issuance choice							
Mutual fund fraction	−0.38**	−0.76***	−0.12	−0.35*	−0.45*	−0.58***	−0.13
	(−2.48)	(−3.20)	(−0.58)	(−1.73)	(−1.84)	(−2.91)	(−0.55)
Panel A–2: Equity issuance choice							
Mutual fund fraction	0.24*	0.34	0.02	0.34**	0.19	0.27*	0.10
	(1.76)	(1.63)	(0.12)	(1.97)	(0.98)	(1.78)	(0.39)
Panel A–3: Bank borrowing choice							
Panel A–3-1: Full sample baseline model							
Mutual fund fraction	0.28***	0.43***	0.15	0.38**	0.18	0.28**	0.24
	(2.65)	(3.03)	(0.97)	(2.57)	(1.15)	(2.23)	(1.33)
Panel A–3-2: Term loan choice							
Mutual fund fraction	0.39***	0.69***	0.01	0.48***	0.23	0.46***	0.08
	(2.89)	(3.92)	(0.05)	(2.70)	(1.22)	(2.77)	(0.34)
Panel A–3-3: Bank/bond choice							
Mutual fund fraction	0.67***	0.99**	0.58	0.35	0.87**	1.04***	0.23
	(2.83)	(2.41)	(1.62)	(1.00)	(2.18)	(3.13)	(0.46)
Panel B: Leverage models							
Mutual fund fraction	−0.04***	−0.04**	−0.03*	−0.03	−0.05**	−0.04**	−0.02
	(−2.62)	(−2.07)	(−1.88)	(−1.36)	(−2.09)	(−2.30)	(−1.06)

other control variables and dummy variables included in the baseline models (as in Tables 3–6) are also included in the estimations.

The estimation results indicate that our central findings are largely robust to using this alternative measure of supply uncertainty. We find that the higher the fraction of bonds held by mutual funds, the less likely the firm is to issue bonds and the more likely it is to issue equity and to borrow from banks. Consistent with the incremental financing results, the firm's market leverage is significantly lower when the fraction of its bonds held by mutual funds is higher. These results are consistent with H1a and H1b. Moreover, the results for incremental financing choices are driven by firms whose bond investor base is more concentrated. These results are consistent with H2. However, the firm's book leverage is not significantly affected by the fraction measure. Unlike the turnover measure, the mutual fund fraction measure has relatively little within-firm variations over time, and we suspect this results in the attenuation of the book leverage result in the firm fixed-effects model.

In summary, our central findings with respect to the firm's corporate financing decisions and capital structure are robust to two alternative measures of bond capital supply uncertainty, one based on the portfolio turnover, and the other based on the share of mutual funds among the firm's investors.

4.4. Discussion

We now consider four alternative explanations for the main results (both leverage and financing choice results). One possibility is that the turnover measure merely captures overall capital market conditions. To rule out this interpretation, we include time fixed-effects (year dummies) in all model specifications to capture overall market conditions. Furthermore, the results in Section 4.3 using the mutual fund fraction measure of supply uncertainty are hard to reconcile with this interpretation.

Second, it is possible that the turnover measure captures fund flows in/out of institutional investors and firms merely respond to them as market timers. We rule out this explanation by including both bond (signed) flows and stock flows as control variables in all of our specifications to capture the effects of capital flows on the firm's financing behavior (the *Market-timing hypothesis*). We find that inflows to institutional investors' holdings of bonds do not increase the firm's probability of issuing bonds (Table 3).[46] This suggests that a simple market-timing

[46] Likewise, inflows to institutional investors holding equity do not significantly increase the firm's probability of issuing equity (Table 4) in most specifications.

story is not sufficient to explain the firm's response to our bond turnover and mutual fund fraction measures.

Next, we consider the possibility that the turnover measure captures the liquidity of the firm's overall securities. To rule out this possibility, we separately include measures of liquidity for the firm's equity. It has a positive effect on the probability of issuing equity, but no effect on the probability of issuing bonds, as expected. The bond turnover measure affects the likelihood of all three financing choices (bond, equity, and loans) in different directions, so it is a distinct measure from the overall liquidity measure. Thus, this result is inconsistent with this interpretation.

Finally, it is possible that the turnover measure captures the liquidity of the firm's bonds. Indeed, the liquidity literature has proposed using a turnover measure similar to ours as a latent liquidity measure (Mahanti, Nashikkar, Subrahmanyam, and Chacko, 2008). They find that, *for relatively frequently traded bonds,* the high turnover bonds are associated with low transaction costs in the secondary market.[47] If investor turnover measures liquidity, as argued by Mahanti, Nashikkar, Subrahmanyam, and Chacko (2008), it seems plausible that the regression results could be capturing a correlation between liquidity and issuance choice. However, the liquidity argument would suggest a positive coefficient, i.e., following Amihud and Mendelson (1986), greater liquidity (turnover) should lower the cost of capital for the bond, and thus increase the firm's probability of issuing a bond. But we find the opposite—high turnover is associated with lower probability of issuing a bond, which is inconsistent with the liquidity argument. Additionally, our results are equally robust using the alternative measures of supply uncertainty not obviously directly related to liquidity, i.e., the mutual fund fraction measure and the flow volatility measure.[48] To conclude, we find that our overall results are not consistent with any of these alternative explanations.

5. Addressing potential endogeneity of baseline results

Our specifications include a variety of observed firm characteristics that are relevant demand-driven determinants of the firm's financing choices and leverage, such as R&D expenditure, Altman's measure of distance from distress, credit rating dummies, as well as industry fixed effects, in all of our estimations. We also employ a two-step construction method for the turnover variable, which alleviates the reverse causation concern. Still, there may be some unobserved risk characteristics of the firm that are correlated with our supply uncertainty measures and that also affect the firm's financing decisions. In other words, our supply uncertainty measure is potentially endogenous[49] and we must address this concern in order to make our results compelling. Our key identification strategy is to construct and use geography-based instrumental variables in IV model estimations of the financing choice and leverage models. To further rule out any alternative omitted variable explanations and to help strengthen the validity of our IV approach, we present additional results using our third measure of supply uncertainty (volatility), a placebo test, a conditional firm fixed-effects logit model, and a subsample analysis.[50]

5.1. IV model specification

5.1.1. Instruments

Our choices of instruments are guided by the economic considerations and, in particular, local bias results in Massa, Yasuda, and Zhang (2009). Since bond holdings are significantly locally biased, the relative prevalence of high supply uncertainty investors (e.g., mutual bond funds) in the firm's local region is likely to exogenously affect the firm's bond investor base. However, these local investor characteristics have no relation to the firm's demand for credit and thus are uncorrelated with the error terms in the main equation.

Based on this idea, we construct two geography-based instruments and use them in our IV estimations of the main models. Our first instrument is the *High local mutual fund fraction dummy*, which captures the prevalence of mutual funds among all the local investors.[51] If the firm is located in an area that is heavily populated by mutual funds (relative to other institutional bond investors), the firm is more likely to be held by mutual funds, all else equal. Thus, we expect this variable to be correlated with the turnover of the firm's bond investors overall, but not correlated with the firm's demand for debt.

Fig. 2 plots how the prevalence of mutual funds among local bond investors varies geographically within the contiguous U.S. states. The fractions of mutual funds among local investors are categorized into high, low, and medium for a given local area. Mutual funds are relatively prevalent (as fractions of all local investors) in the Northeast, Coastal California, as well as pockets of midland America, and are comparatively less important as sources of local funds in the South, Northwest, and in many of the Midwestern states. We exploit this geographic variation in the prevalence of mutual funds, which have higher turnover as well as flow volatility

[47] This is quite intuitive and can be thought of as products of complementary two-way causation: on the one hand, high-turnover funds are attracted to low transaction cost bonds; on the other hand, market makers demand lower bid-ask spreads for bonds that are held by high-turnover funds, since they are easier to obtain than those bonds held by low-turnover investors.

[48] See Section 5.3 and Table 9 below for results using the flow volatility measure of supply uncertainty.

[49] The direction of the bias depends on the nature of unobserved risk that the supply uncertainty measures may proxy for. On the one hand, high-growth firms (e.g., tech firms) are risky and have low leverage. If they are more likely to be held by high supply uncertainty investors, the potential endogeneity biases us *towards* finding our results, so it is a serious concern. In this case, correcting for endogeneity should move the turnover coefficient towards zero. On the other hand, distressed firms are also risky, but tend to be overleveraged. If they are more likely to be held by high supply uncertainty investors, then endogeneity biases us *away* from finding our results, so it is a less serious concern. Moreover, controlling for endogeneity in this case should move the coefficient away from zero and strengthen our results.

[50] We thank the anonymous referee for suggesting these exercises.

[51] See the Appendix A for the detailed definitions of each of the instrument variables.

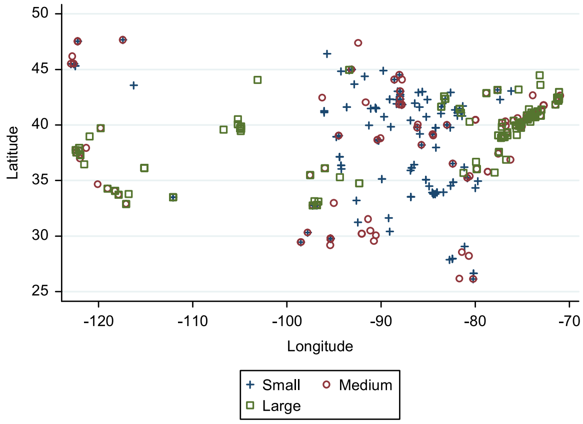

Fig. 2. Prevalence of mutual funds among local bond investors. This figure plots how the prevalence of mutual funds among local bond investors varies geographically within the contiguous U.S. states. The fractions of mutual funds among local investors are categorized into large, small, and medium for a given local area.

than insurance companies, to instrument for our firm-level supply uncertainty measure.[52]

A critical identifying restriction for this variable to be a valid instrument is that the firms' choice of headquarters location is not correlated with prevalence of certain types of investors in the home area.[53] Since firms typically do not start issuing bonds until they are quite mature, we think it is reasonable to assume that firms do not consider proximity to bond institutional investors when choosing where to locate at the time of founding.[54] We find that not only is this instrument significantly correlated with the firm's turnover (and volatility) measures, but also that it is a "strong" instrument in the sense of Staiger and Stock (1997), i.e., its first-stage F-statistic exceeds the rule-of-thumb threshold of 10 (reported in Table 8). We thus use this instrument in the MLE estimation of the IV probit model for Eq. (6).

This instrument, however, varies relatively little over time for a given firm, so while it is a good instrument for capturing the predominantly cross-sectional variation of the turnover measure in the bond-quarters pooled regression of Eq. (6), it is not a sufficiently strong instrument for capturing the within-firm, time-series variation of the turnover measure in the fixed-firm regression of Eq. (7).[55] In particular, its first-stage F-statistic is less than 10.

Thus, in the firm fixed-effects leverage models, we employ a second instrument, *Local turnover*, in conjunction with the *High local mutual fund fraction* dummy, to meet the strong-instrument criteria. This second instrument captures the value-weighted average of the turnover among all the local investors and has more significant variations over time. These two instruments are significantly correlated with the within-firm variation of the turnover (across time), and their joint first-stage F-statistic exceeds 10. Thus, they are strong instruments for the firm fixed-effects models of Eq. (7). Moreover, they also meet the overidentification criteria in the leverage models (p-values reported in Table 8, Panel B).

While our instruments seem to satisfy the statistical criteria, we acknowledge that the presence of some omitted variables inducing a correlation between mutual fund concentration in the headquarters location and capital structure could still challenge the validity of our instruments. For example, if high tech firms tend to locate in California, and these firms tend to have low leverage due to the nature of their assets or investment opportunities, and California has a heavy concentration of mutual funds (for some other reason), this could be problematic. We address this concern in three ways. First, we conduct a placebo test to show that the geography-based instruments are uncorrelated with financing choices in the period before mutual funds held significant amounts of corporate bonds. This will be presented in Section 5.4 and reported in Table 10. Second, we include the firm fixed-effects when estimating leverage models (as reported in Panel B of Tables 8, 9). Since all the identification is coming from within-firm changes in the instruments in the fixed-effects models and firms rarely change headquarters location, this specification rules out any explanations based on correlations between headquarters location and unobserved capital structure determinants. Finally, we re-estimate the firm's financing choices using the IV conditional firm fixed-effects logit model to further mitigate the concern that omitted-variable bias drives our result. This will be presented in Table 11.

5.1.2. Local economic conditions

It is possible that — test of overidentifying restrictions notwithstanding — our instruments (local investor attributes) are not orthogonal to the firm's financing and leverage decisions, but pick up some local economic conditions that affect the firm's capital structure. To

[52] See Becker, Ivkovic, and Weisbenner (2011) and Becker, Cronqvist, and Fahlenbrach (2011) for use of geographic variation as instruments in other studies.

[53] We are aware that, even if we satisfy this particular identifying restriction, broader conditions might exist that would still threaten the validity of our instruments (see below for additional discussion and our three-pronged approach to address this concern).

[54] This is in sharp contrast to, for example, start-ups' location choices relative to locations of venture capitalists (VCs) (they often explicitly choose to be located within driving distance of each other).

[55] Recall from Section 3 that the variation in the mutual fund fraction measure is chiefly cross-sectional, whereas the variations in the turnover (and volatility) measures are driven by both cross-section as well as time-series variation within firms.

Table 8
IV estimation results.

This table presents the IV estimation results of the firm's financing choice and leverage models. Panel A presents the MLE estimation results of IV probit models to analyze the firm's incremental finance choices such as bond, equity, and bank loans. For the bank loans vs. bond choice analysis, we further disaggregate the bank loan choice into term loans and (non-CP) line of credit. We use the *Local mutual fund fraction dummy* as our instrument for Panel A. Panel B presents the linear IV estimation results of the leverage models. We use the *High local mutual fund fraction dummy* and *Local turnover* as our instruments for Panel B. See Appendix A for the definitions of the instrument variables. For the sake of brevity, only the coefficients and *t*-statistics (in parentheses) for the variable of interest, the *Instrumented turnover*, are reported. We also report the first-stage *F*-statistics and *p*-values foroveridentificationtests (in Panel B). We include two additional variables to proxy for local economic conditions. One is an urban dummy, which equals one if the firm is located within 100 miles from one of the top ten largest cities in the US (US Census file 2000). The other one is the state economic index, i.e., the state-coincident indexfrom the Federal Reserve Bank of Philadelphia. The symbols *, **, and *** indicate statistical significance of the test that the coefficient is different from zero at the 10%, 5%, and 1% level, respectively.

Panel A: IV probitmodels for the firm's financing choices

Independent variables	Bond (1)	Equity (2)	Bank (3)	Bond vs. bank (5)	Bond vs. termloan (6)	Bond vs. line of credit (7)
Turnover(instrumented)	−7.01***	6.45***	1.35	7.28***	7.19***	7.98***
	(−3.57)	(2.66)	(0.40)	(3.76)	(2.77)	(4.84)
Urban dummy	0.01	−0.12	−0.06	−0.02	−0.12	−0.073
	(0.09)	(−1.57)	(−0.80)	(−0.20)	(−0.91)	(−0.78)
State economic index	−0.04	−0.29	0.03	−0.17	−0.34	−0.05
	(−0.11)	(−0.83)	(0.09)	(−0.44)	(−0.71)	(−0.13)
Control variables	Y	Y	Y	Y	Y	Y
Clustering at	Firm	Firm	Firm	Firm	Firm	Firm
No. of obs.	4101	4101	4101	1166	816	1121
First-stage *F*-stat	17.67	17.67	17.67	11.24	12.03	9.33

Panel B: Linear IV models for leverage

Independent variables	Market leverage (1)	Book leverage (2)	Market leverage (dynamicadjustment) (3)	Book leverage (dynamicadjustment) (4)
Turnover(instrumented)	−0.69***	−0.36**	−0.68**	−0.30*
	(−2.64)	(−2.11)	(−2.46)	(−1.75)
Urban dummy	−0.05	−0.05	−0.06	−0.05
	(−0.66)	(−1.39)	(−0.86)	(−1.54)
State economic index	−0.18**	−0.02	−0.11	−0.00
	(−2.04)	(−0.41)	(−1.46)	(−0.03)
Control variables	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y
Clustering at	Firm	Firm	Firm	Firm
No. of obs.	4098	4098	4061	4061
First-stage *F*-stat	14.29	14.29	11.46	11.46
Overidentification Hansen (*p*-value)	0.75	0.92	0.37	0.24

address this possibility, we also include proxies for local economic conditions as additional control variables in our IV model.

We use two variables to capture the local economic conditions. The first variable, *Urban* dummy, equals one if the firm is located within one hundred miles from one of the top ten cities in the U.S.[56] The second variable, the *Coincident index*, is a state-level economic condition index variable that has been developed at the Federal Reserve Bank of Philadelphia,[57] which in turn is based on a national coincident index methodology developed by Stock and Watson (1989). The coincident indexes combine four state-level indicators to summarize current economic conditions in a single statistic. The four state-level variables in each coincident index are nonfarm payroll employment, average hours worked in manufacturing, the unemployment rate, and wage and salary disbursements deflated by the consumer price index (U.S. city average). We include these two variables in both the first- and second-stage regressions for the IV model.

5.2. IV estimation results

The IV estimation results are presented in Table 8. Panels A and B present the results for the IV probit models for the firm's financing choices and the linear IV (firm fixed-effect) models for leverage, respectively. Standard errors are adjusted for estimation errors and reported with the degrees of freedom adjustment for fixed effects (in cases of leverage models in Panel B). The two local economic condition variables are insignificant in all model specifications except

[56] The ten cities (according to the 2000 Census) are: New York, Los Angeles, Chicago, Houston, Philadelphia, Phoenix, San Antonio, San Diego, Dallas, and Detroit.

[57] For details and documentation on the development of the state indexes, see Crone and Clayton-Matthews (2005).

Table 9
IV results based on bond investor flow volatility.
This table presents the IV estimation results of the firm's financing choice and leverage models using an alternative measure of supply uncertainty—the value-weighted average volatility of fund flows. Panel A presents the IV probit results for the firm's financing choice models; Panel B presents the IV firm fixed-effects model results for the firm's leverage. For brevity, only the coefficient for the key explanatory variable—the fund volatility—is shown; the same set of control variables as in the IV model reported in Table 8(including the local economic condition variables) are used in both the first-stage and second-stage regressions. We construct the flow volatility as follows. First, for each investor *j* in quarter *t*, we measure the quarterly asset flow as the change in *j*'s asset holdings divided by its holdings in the previous quarter. We define the flow volatility of investor *j* in quarter *t* as the standard deviation of *j*'s quarterly asset flows in the previous 12 quarters. Then, for each bond-quarter, we calculate the holdings-weighted average fund flow volatility among all investors that hold the bond. The symbols *, **, and *** indicate statistical significance of the test that the coefficient is different from zero at the 10%, 5%, and 1% level, respectively.

Panel A: IV probit models for the firm's financing choices

Independent variables	Bond (1)	Equity (2)	Bank (3)	Bond vs. bank (5)	Bond vs. termloan (6)	Bond vs. line of credit (7)
Volatility(instrumented)	−24.82***	23.54***	7.14	23.43***	27.86**	25.95***
	(−3.70)	(3.15)	(0.70)	(3.59)	(2.29)	(3.81)
Control variables	Y	Y	Y	Y	Y	Y
Local economic conditions	Y	Y	Y	Y	Y	Y
Clustering at	Firm	Firm	Firm	Firm	Firm	Firm
No. of obs.	3531	3531	3531	992	702	966
First-stage *F*-stat	18.87	18.87	18.87	14.70	8.62	15.88

Panel B: Linear IV models for leverage

Independent variables	Market leverage (1)	Book leverage (2)	Market leverage (dynamicadjustment) (3)	Book leverage (dynamicadjustment) (4)
Volatility(instrumented)	−2.05*	−1.52*	−1.93*	−1.43*
	(−1.90)	(−1.95)	(−1.78)	(−1.86)
Control variables	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y
Local economic conditions	Y	Y	Y	Y
Clustering at	Firm	Firm	Firm	Firm
No. of obs.	3523	3523	3494	3494
First-stage *F*-stat	15.53	15.53	12.04	12.04

market leverage, where the state coincident index variable is negative and significant. Since higher values of this variable indicate better local economic conditions, this result suggests that, ceteris paribus, the market leverage of the firm is lower when the state in which the firm is located is in better shape because the market value of the equity of the firm goes up, pushing market leverage down. More importantly, not only does the turnover measure retain its effect on the firm's financing choices and the overall leverage, but also the size of its coefficient increases by a factor of between 4 and 10. We rule out the possibility that this is due to weak instruments by aforementioned first-stage *F*-statistics exceeding 10. The inclusion of local economic condition variables as control variables also addresses the concern that our instruments pick up some local economic conditions that affect the firm's capital structure. Instead, a likely explanation for the difference in the coefficient is that our turnover measure is a noisy measure of the true supply uncertainty of the firm's bond investors and the increase in the coefficient is the result of a reduction in the standard attenuation bias present when variables are measured with error. If this is the case, the true economic effect is closer to the IV estimates, which suggests a much larger result. For example, the IV results suggest that one standard deviation increase in the turnover (0.057 for the within-firm average) leads to −4% (−2%) absolute reductions in the market (book) leverage,[58] as compared with the only −0.5% (−0.3%) absolute reductions that the non-instrumented models (Table 6) suggest. We also note that the inclusion of firm fixed effects in the leverage model helps strengthen our identification here, since the identification is solely based on within-firm differences in the instruments.

5.3. IV results with volatility

While our main measure of supply uncertainty—value-weighted average turnover of investors' portfolios—is designed to capture liquidity constraints faced by investors holding a given firm's bonds, other considerations, such as strategically motivated trades by the funds, could impact this measure as well. Thus, we check the robustness of our IV estimation results by presenting the IV model results using an alternative measure of supply uncertainty—the value-weighted average volatility of investors' fund flows.

The results of the IV model estimations using volatility as the alternative measure of supply uncertainty are presented in Table 9. Panel A presents the IV probit results for the firm's

[58] $0.057*(-0.69)=-3.93\%$. $0.057*(-0.36)=-2.05\%$.

financing choice models; Panel B presents the IV firm fixed-effects model results for the firm's leverage. For brevity, only the coefficient for the key explanatory variable—the volatility—is shown; the same set of control variables as in the IV model reported in Table 8 (including the local economic condition variables) are used in both the first-stage and second-stage regressions. The first-stage *F*-statistics reported at the bottom of the panels indicate that the instruments are strong in the sense of Staiger and Stock (1997) except in column 6, Panel A.

The estimated coefficients using this alternative measure of supply uncertainty confirm our main findings: firms with bond investors that exhibit higher flow volatility are, ceteris paribus, significantly less (more) likely to use bond (equity and bank) financing, and have lower leverage. The results are not only statistically significant but also of economically meaningful magnitude: using the average within-firm standard deviation for the volatility variable (0.019), the leverage coefficients suggest that one within-firm standard deviation increase in the volatility measure is associated with −4% (−3%) absolute reduction in market (book) leverage.[59] Note that these are similar in magnitude to those IV results reported in Table 8 using the turnover measure of supply uncertainty. The fact that the two measures of supply uncertainty give us qualitatively and quantitatively similar results is reassuring and suggests that our findings are not driven by our particular proxy choices.

5.4. Placebo test results

Even if firms do not make headquarters location decisions based on their distance to bond investors, there are still concerns that some omitted local variables may give rise to the correlation between mutual fund concentration in the headquarters location and capital structure other than the firm's concern over supply uncertainty. Therefore, to further address the concern that our results may be driven by some unobserved local economic conditions, we conduct a placebo test. Specifically, before the mid-1980s, mutual funds held few corporate bonds, and pensions and insurance companies were the dominant bond investors.[60] If bond capital supply uncertainty resulting from mutual fund flows is driving the variation in financing policies across geographic regions, then we should not see this association in the earlier period. In other words, do firms headquartered in the areas with high mutual fund concentration in the 2000s have different financial policies from other firms in the 1980s?

The placebo test results are presented in Table 10. We measure the local mutual fund fraction for each firm by taking the median across the sample period quarters in 1998–2005. Then we examine the effect of this variable on the firm's financing choices and leverage. All the other control variables in the baseline model are also included wherever available.[61] The estimation period is 1980–1985 for all the models except the firm's bank borrowing choice models (columns 3 and 4), which we examine using the period 1986–1990 because the LPC DealScan coverage for bank loans starts in 1986.

The coefficient for the local mutual fund fraction variable (as observed in the 2000s) is not significantly different from zero in column 1. This suggests that firms located in high mutual fund concentration areas in the 1998–2005 period were not more or less likely to issue bonds than other firms in 1980–1985, holding other things constant. Similarly, the coefficient for this variable is not significantly different from zero in any of the other columns (2–6). Thus, firms in high mutual fund concentration areas in the 1998–2005 period were not more or less likely to issue equity or borrow from banks, nor were they more or less leveraged than other firms in earlier periods when mutual funds held little corporate bonds.

This variable measures location-based bond capital supply uncertainty that did not exist in the 1980s and therefore should not affect the firm's financing policies/leverage back then. And we indeed find that it does not.[62] This result further alleviates the concern that our main findings are driven by spurious correlations caused by some omitted geographic characteristics that are correlated with both the firm's financial policy and investor characteristics (such as concentration of mutual funds).

5.5. IV conditional firm fixed-effects logit model for the firm's financing choices

While the placebo test helps mitigate the omitted variable bias concern, we may still be subject to this bias if the correlation arose after the mid-1980s. Therefore, to further strengthen the identification, we employ a firm fixed-effects model in the discrete-choice setting. Since fixed-effects probit models are subject to the incidental parameter problem,[63] resulting in inconsistent coefficients, we instead use the conditional fixed-effects logit model.[64] Like the linear firm fixed-effects model we use to analyze the leverage, this framework restricts the identification to come only from within-firm changes in the instrument, thus ruling out any explanations based on correlation between headquarters location and unobserved capital structure determinants. However, one implication of the new specification is that the observations for firm *i* that never issues a given instrument (e.g.,

[59] $0.019\times(-2.05)=-3.90\%$. $0.019\times(-1.52)=-2.89\%$.

[60] U.S. Flow of Funds.

[61] Bond turnover and flows are not included because data are not available to construct this variable for the early years used for estimation here. Similarly, stock turnover and flow variables are not included because institutional ownership data in the early years are quite incomplete.

[62] In unreported analyses, we also use (i) the median value of firm *i*'s high local mutual fund fraction dummy (as defined in the Appendix A) across the sample period quarters (1998–2005) and (ii) the median value of the instrumented turnover variable across the sample period quarters (1998–2005) (where it is instrumented using high local mutual fund fraction dummy as the instrument, as in the main analysis) as the key explanatory variable, and confirm that the results are qualitatively unchanged.

[63] Greene (2003, pp. 690, 697).

[64] Allison (2009, p. 47).

Table 10
Placebo test.

This table presents the results of a placebo test for our baseline results. In particular, we examine whether firms headquartered in the areas with high mutual fund concentration in the 2000s have different financial policies from other firms in the 1980s (1980–1985 for bond/equity issuance decisions and leverage; 1986–1990 for bank borrowing choice models due to lack of data coverage in earlier years).The variable *Local mutual fund fraction* for firm *i* is defined as the median value of *i*'s local mutual fund fraction across the sample period (1998–2005). "Firm leverage" in columns 5 and 6 refers to the initial market (book) leverage in 1980, respectively. All the independent variables are defined in the Appendix A. Standard errors are clustered at the firm level. The symbols *, **, and *** indicate statistical significance of the test that the coefficient is different from zero at the 10%, 5%, and 1% level, respectively.

	Bond choice (1)	Equity choice (2)	Bank choice (3)	Bank vs. bond choice (4)	Market leverage (5)	Book leverage (6)
Local mutual fund fraction	0.42	0.70	−0.01	−0.69	0.03	0.01
	(0.49)	(1.45)	(−0.03)	(−0.58)	(0.48)	(0.24)
Stock holding fraction	0.56	−0.58	0.27	1.57	−0.14***	−0.10***
	(1.09)	(−1.28)	(0.80)	(1.47)	(−3.33)	(−3.25)
Abnormal return	0.32	0.83***	0.31**	−0.10	−0.07***	−0.03**
	(1.02)	(4.19)	(2.16)	(−0.18)	(−4.77)	(−2.23)
Amihud'silliquidity	0.15	−0.72***	−0.12	−0.43	0.01	0.00
	(0.68)	(−2.96)	(−0.75)	(−0.73)	(0.68)	(0.22)
Stock return volatility	11.13	−15.42	13.75**	56.05**	1.50	1.14
	(0.65)	(−1.61)	(2.28)	(2.51)	(1.51)	(1.55)
Asset tangibility	−0.48	−0.19	−1.13***	−1.63*	0.09	0.03
	(−0.72)	(−0.37)	(−3.42)	(−1.86)	(1.55)	(0.62)
Firmsize	0.38***	0.14**	0.03	−0.77***	0.01	0.01*
	(5.95)	(2.57)	(0.65)	(−5.26)	(1.18)	(1.72)
Profitability	1.45	−1.09	1.45**	−0.29	−0.06	−0.22
	(1.03)	(−1.28)	(2.21)	(−0.18)	(−0.56)	(−1.45)
R&D	−8.12**	−0.96	−1.15	−4.29	−0.30	−0.20
	(−2.23)	(−0.44)	(−0.67)	(−0.77)	(−1.46)	(−0.96)
R&D dummy	−0.21	−0.18	0.42***	0.05	−0.01	−0.02
	(−1.15)	(−1.10)	(3.28)	(0.14)	(−0.48)	(−1.29)
Altman's *z*-score	0.08	−0.24**	−0.16**	−0.30	−0.06***	−0.03***
	(0.70)	(−2.28)	(−2.12)	(−1.35)	(−5.37)	(−3.08)
Asset maturity	0.01	0.00	−0.02**	−0.04	−0.00*	−0.00
	(0.68)	(0.26)	(−2.56)	(−1.48)	(−1.70)	(−1.09)
Capital expenditure	2.48*	1.33	1.50**	−1.63	−0.03	0.04
	(1.75)	(1.38)	(2.12)	(−0.71)	(−0.36)	(0.70)
Market-to-book	−0.44**	0.24***	−0.36***	−0.52*	−0.04***	0.01
	(−2.43)	(2.96)	(−3.58)	(−1.67)	(−3.10)	(0.55)
Firmleverage	0.70	1.06**	0.48	−0.55	0.46***	0.49***
	(0.92)	(2.07)	(1.20)	(−0.49)	(10.86)	(9.23)
Year, location, industry,& ratings dummies	Y	Y	Y	Y	Y	Y
Clustering	Firm	Firm	Firm	Firm	Firm	Firm
(Pseudo) *R*-squared	0.3240	0.1916	0.1693	0.6486	0.7172	0.6039
Number of obs.	1442	1442	2123	429	1303	1303

equity) during the sample period are dropped from the analysis, since for this firm, $y_{i1}=0$, $y_{i2}=0,\ldots,$ $y_{iT}=0$, for $t=1, 2,\ldots, T$, and Prob($y_{i1}=0$, $y_{i2}=0,\ldots,$ $y_{iT}=0$ |sum of y_{it}'s$=0)=1$, so these observations contribute nothing to the conditional likelihood function.[65] This is in contrast to the linear firm fixed-effects model used to analyze the firm's leverage, which is free of the incidental parameter problem. Thus, we expect the explanatory power of supply uncertainty to go down with this specification. Notwithstanding this issue, the specification is useful in checking whether our results are driven by the omitted variable bias.

The results are presented in Table 11. Columns 1–3 present the results using the turnover measure of supply uncertainty; columns 4–6 present the results using the flow volatility measure. In both sets of results, we find that (the instrumented) supply uncertainty measures continue to have negative and significant effects on the firm's probability of issuing a bond, and positive and significant effects on the firm's probability of issuing equity. The effects on bank loans are positive as well, though not statistically significant.[66] Overall, we find that the main discrete-choice results are robust to this firm fixed effects specification, which is reassuring.

[65] Greene (2003, p. 698).

[66] The fact that this conditional logit framework with firm fixed effects essentially discards any differences between firms and focuses only on within-firm differences may explain the attenuation of the bank loan results. Also, the fact that different observations are dropped from the analysis depending on the financing choices (bond, equity, and bank loan) makes comparisons across financing choices difficult for this model specification. In additional unreported analysis, we also conducted a two-stage IV estimation of a linear probability model with firm fixed effects (which avoids the need to drop observations for firms never issuing a particular instrument) and obtain qualitatively the same result—i.e., supply uncertainty has negative (positive) and significant effects on the firm's probability of issuing a bond (equity), and positive and insignificant effects on bank loans.

5.6. Subsample results with high-growth, low-profitability firms

As the final test, we conduct a subsample analysis based on firms' growth and profitability characteristics. If our results are driven by the firm's concern about future funding shocks, this effect should be most pronounced among those firms likely to have the largest future financing needs—i.e. high-growth, low-profitability firms. We first construct an index that captures the firm's sales growth and profitability[67] and compute the industry median index values at the three-digit SIC code level. We further divide our sample firms into those in high- (above median) and low- (below median) three-digit SIC sectors. We then re-estimate our IV model regressions separately for the high- and low-index subsamples and compare the coefficients in the two subsamples.

The results are presented in Table 12. Panel A presents the IV probit results for the firm's financing choice models; Panel B presents the IV firm fixed-effects model results for the firm's leverage. For brevity, only the coefficient for the turnover variable is shown; the same set of control variables as in the IV model reported in Table 8 (including the local economic condition variables) are used in both the first-stage and second-stage regressions. The first-stage *F*-statistics reported at the bottom of the panels indicate that the instruments are strong in the sense of Staiger and Stock (1997) except for the low-index subsample in Panel B.

The results suggest that the effect of the investors' supply uncertainty on the firm's financing choices and leverage is significant for high-growth/low-profitability sector firms. As in the all-sample IV results reported in Table 8, these firms are significantly less (more) likely to issue bonds (equity) and have lower leverage when they face higher supply uncertainty. In contrast, firms in sectors with low growth and/or high profitability have less concerns for future funding shocks, and their financing choices and leverage are thus not significantly sensitive to their bond investors' credit supply uncertainty. These subsample results are in line with our economic interpretation of the main results and support the view that financing choices and leverage of firms that are dependent on future external funding availability are sensitive to the supply uncertainty of their bond investors.

6. The choice of debt maturity

In this section, we consider the effects of supply uncertainty on the firm's choice of debt maturity (H3). The key prediction is that firms are more likely to issue long-maturity debt when facing higher supply uncertainty from bond investors. We test this prediction by using our turnover measure and employing both the probit and the Tobit model specification, where the dependent variable measures (i) whether the firm issues long-maturity debt and (ii) the maturity of debt chosen, respectively. In addition, because the theory of debt maturity emphasizes the refinancing risk of *short-term* debt, we measure the credit supply uncertainty of bond investors in short- and long-term categories separately and test whether the effect of supply uncertainty on the firm's debt maturity decision is driven by the supply uncertainty in the short-term category.

For the probit model, we use the following model specification:

$$\begin{aligned}LongMaturityDebt_{i,t} = \beta' X_{i,t-1} + \big[Turnover\ (all,\ weighted)_{i,t-1}\ or\\ Turnover\ (short,\ long)_{k_i,t-1}\big]\delta_{maturity}\\ + industry\ dummies_{j_i}{}'\beta_j + year\ dummies_t{}'\beta_t + credit\ dummies_{k_i}{}'\beta_k\\ + location\ dummies_{l_i}{}'\beta_l + \varepsilon_{i,t},\end{aligned} \tag{10}$$

where $LongMaturityDebt_{i,t}$ is a dummy taking the value of one if the firm i issues long-maturity debt (longer than five years) in year t and zero if it issues short-maturity debt (five years or shorter); $X_{i,t-1}$ is the control firm and debt characteristics, measured in the fiscal period immediately prior to the debt issue date; $Turnover(all)_{i,t-1}$ is as defined before; $Turnover(weighted)_{i,t-1}$ is the maturity-weighted turnover across all the bonds of an issuer where the weight for each bond is 1/time-to-maturity.[68]

We are not able to measure supply uncertainty of the firm-specific investors for a specific maturity category using existing debt of a given firm, because not all firms have both short- and long-term bonds outstanding in a given period. Instead, we calculate the value-weighted average of bond turnover across all the institutional investors with holdings in each rating-maturity level. *Turnover(short)* is the value-weighted average turnover for bonds with maturity less than three years for a given rating category from AAA to NR (ten categories total). *Turnover(long)* is the value-weighted average turnover for bonds with maturity longer than five years in a given rating category.

For the Tobit model, we use the following model specification:

$$\begin{aligned}Maturity_{i,t} = \beta' X_{i,t-1} + [Turnover(all,\ weighted)_{i,t-1}\ or\\ Turnover(short,\ long)_{k_i,t-1}]\delta_{maturity}\\ + industry\ dummies_{j_i}{}'\beta_j + year\ dummies_t{}'\beta_t\\ + credit\ dummies_{k_i}{}'\beta_k + location\ dummies_{l_i}{}'\beta_l + \varepsilon_{i,t},\end{aligned} \tag{11}$$

where $Maturity_{i,t}$ is the weighted-average (weighted by par amount) maturity of the debt issued by firm i in year t, and the other variables are as defined above.

To address the potential endogeneity of the debt issuance choice, we estimate a series of two-stage regression models (Maddala, 1983) where we first run an (unreported) first-stage regression of debt issuance choice model and include the inverse Mills' ratio (Heckman's lambda) in the second-stage regression. The second-stage model is specified as in Eqs. (10) and (11). To see whether

[67] The index value equals the (normalized) sales growth−(normalized) profitability, so higher index values indicate faster growth and/or lower profitability.

[68] Thus, more weight is given to a bond the shorter its maturity. If the supply uncertainty of short-maturity debt investors drives the firm's maturity choice, this variable is expected to have greater explanatory power than our regular turnover variable.

Table 11
Firm's financing choices using conditional firm fixed-effectslogitmodel.

This table presents the two-stage IV estimation results of the firm's financing choice using the conditional firm fixed-effectslogit model. Columns 1–3 present the results using the turnover measure of supply uncertainty; columns 4–6 present the results using the flow volatility measure. The same set of control variables as in the IV model reported in Table 8 are used in both the first-stage and second-stage regressions. All the independent variables are defined in the Appendix A. We use bootstrapping (100 replications with clusters) to adjust the standard errors in the second-stage regression. We also report the first-stage *F*-statistics. The symbols *, **, and *** indicate statistical significance of the test that the coefficient is different from zero at the 10%, 5%, and 1% level, respectively.

	Conditional (fixed-effects) logitregressions					
Independent variables	Bond (1)	Equity (2)	Bank (3)	Bond (4)	Equity (5)	Bank (6)
Turnover(instrumented)	−34.43**	39.75***	2.22			
	(−2.44)	(2.64)	(0.25)			
Flow Volatility (instrumented)				−130.08***	99.60**	12.41
				(−2.96)	(2.54)	(0.53)
Bond flow	−0.14	−1.51*	0.43	−2.13*	1.10	0.70
	(−0.11)	(−1.67)	(0.69)	(−1.94)	(1.29)	(1.22)
Bond-to-corporate debt ratio	−4.22***	0.93	0.32	−4.13***	−0.22	−0.24
	(−4.92)	(1.08)	(0.65)	(−5.46)	(−0.22)	(−0.44)
Stock turnover	2.45	−2.55	−2.16	1.46	−0.43	−2.40
	(1.07)	(−0.93)	(−1.55)	(0.53)	(−0.14)	(−1.48)
Stock flow	−1.33	−2.70	−4.59*	0.58	−0.59	−5.24*
	(−0.28)	(−0.58)	(−1.71)	(0.10)	(−0.12)	(−1.75)
Stock holding fraction	0.27	0.11	0.12	0.89	−0.55	0.31
	(0.40)	(0.14)	(0.33)	(1.07)	(−0.78)	(0.77)
Abnormal return	0.20	0.53**	0.07	0.26	0.40	0.08
	(0.76)	(2.15)	(0.52)	(0.88)	(1.35)	(0.52)
Amihud'silliquidity	−0.01*	−0.01	0.00	−0.01	−0.02*	0.00
	(−1.82)	(−1.14)	(0.74)	(−1.56)	(−1.96)	(0.57)
Stock return volatility	−4.51*	−2.74	−0.23	−2.27	−3.79	−0.46
	(−1.66)	(−1.04)	(−0.13)	(−0.65)	(−1.40)	(−0.27)
Asset tangibility	−4.36*	4.00	0.86	−6.40**	3.09	1.17
	(−1.66)	(1.50)	(0.55)	(−2.06)	(0.94)	(0.75)
Assetsize	−0.53	−0.51*	−0.56***	−0.88*	−0.30	−0.58***
	(−1.53)	(−1.71)	(−2.97)	(−1.86)	(−0.71)	(−2.63)
Profitability	6.10**	−3.59	1.17	9.30**	−2.28	2.06
	(2.00)	(−1.24)	(0.72)	(2.21)	(−0.59)	(1.22)
R&D	0.34	30.56**	2.25	1.85	29.05**	−1.44
	(0.03)	(2.44)	(0.35)	(0.13)	(2.17)	(−0.17)
R&D dummy	1.12	0.08	−0.07	1.87	0.23	0.19
	(0.58)	(0.07)	(−0.18)	(0.26)	(0.11)	(0.45)
Altman's *z*-score	−0.19	0.17	0.16	−0.68	0.30	0.25
	(−0.62)	(0.55)	(0.97)	(−1.52)	(0.75)	(1.40)
Asset maturity	0.03	−0.04	0.01	0.01	−0.01	0.01
	(1.27)	(−1.27)	(0.43)	(0.47)	(−0.42)	(0.29)
Capital expenditure	1.72	2.08	−3.21*	3.46	1.65	−4.49**
	(0.65)	(0.68)	(−1.93)	(1.10)	(0.48)	(−2.31)
Market-to-book	0.05	0.54**	0.03	0.39*	0.36	0.08
	(0.31)	(2.53)	(0.25)	(1.84)	(1.36)	(0.50)
Book leverage	−1.12	2.21	−0.89	−3.62**	2.88*	−1.31
	(−0.62)	(1.22)	(−1.08)	(−1.98)	(1.76)	(−1.38)
Urban dummy	0.02	−0.70	−0.58	0.73	−1.26	−0.87
	(0.01)	(−1.00)	(−1.04)	(0.12)	(−1.62)	(−1.62)
State economic index	−0.63	−3.70	1.16	−5.33*	−4.37	2.89**
	(−0.28)	(−1.08)	(0.89)	(−1.84)	(−1.31)	(2.24)
Year FE	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y
Clustering at	Firm	Firm	Firm	Firm	Firm	Firm
No. of obs.	1,738	1,396	3345	1,334	1,067	2,776
First-stage *F*-stat	11.74	11.74	11.74	16.81	16.81	16.81

supply uncertainty affects the firms' choice of debt maturity, we will focus on the coefficient $\delta_{maturity}$ in Eqs. (10) and (11).

The results are reported in Table 13. Columns 1–4 present the results of the probit model; columns 5–8 present the results of the Tobit model. The results show that firms indeed are more likely to issue long-maturity debt when they face higher supply uncertainty. Furthermore, the result is largely driven by supply uncertainty of short-term bond investors as opposed to long-term bond investors, which is also in line with the theory. While the coefficient on the overall turnover is not significant in the Tobit model in column 5, the effects of both the maturity-weighted turnover and short-maturity category turnover on the chosen debt maturity are positive

Table 12
Subsample results based on growth and profitability.

This table presents the IV estimation results on subsamples built based on the "salesgrowth & profitability" index. We first compute the industry median values of the index—defined as the firm's (normalized) sales growth minus (normalized) profitability, at the three-digit SIC code level. We then divide our sample firms into those in high- (above median) and low- (below median) three-digit SIC sectors. We then re-estimate our IV model regressions separately for the high- and low-index subsamples. Panel A presents the IV probit results for the firm's financing choice models; Panel B presents the IV firm fixed-effects model results for the firm's leverage. For brevity, only the coefficient for the turnover variable is shown; the same set of control variables as in the IV model reported in Table 8 (including the local economic condition variables) are used in both the first-stage and second-stage regressions. We also report the first-stage F-statistics and p-values for overidentification tests (in Panel B).

Panel A: IV probit models for the firm's financing choices

	High-index subsample			Low-index subsample		
Independent variables	Bond (1)	Equity (2)	Bank (3)	Bond (1)	Equity (2)	Bank (3)
Turnover(instrumented)	−7.24***	5.633**	2.77	−4.39	4.68	1.51
	(−6.65)	(2.37)	(0.82)	(−1.23)	(1.46)	(0.36)
Control variables	Y	Y	Y	Y	Y	Y
Local economic conditions	Y	Y	Y	Y	Y	Y
Clustering at	Firm	Firm	Firm	Firm	Firm	Firm
No. of obs.	2026	2026	2026	2043	2043	2043
First-stage *F*-stat	17.98	17.98	17.98	21.42	21.42	21.42

Panel B: Linear IV models for leverage

	High-index subsample		Low-index subsample	
Independent Variables	Market leverage (1)	Book leverage (2)	Market leverage (1)	Book leverage (2)
Turnover (instrumented)	−0.83***	−0.56***	0.28	0.06
	(−3.05)	(−2.95)	(0.53)	(0.17)
Control variables	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y
Local economic conditions	Y	Y	Y	Y
Clustering at	Firm	Firm	Firm	Firm
No. of obs.	1946	1946	1993	1993
First-stage *F*-stat	12.55	12.55	4.59	4.59
Overidentification Hansen (*p*-value)	0.85	0.85	0.64	0.64

and significant (columns 6–8), again suggesting that the results are driven by turnover among short-maturity bond investors.

The signs of the control variables are interesting. Firms with higher stock return volatility (a measure of risk) tend to issue shorter-maturity debt, whereas firms with high profitability and higher book leverage borrow at longer maturity. These results suggest that better credit quality (i.e., lower default and higher loss recovery rate) is generally associated with longer maturity in the sample.

To summarize, the results of the debt maturity choice model estimations are generally consistent with hypothesis H3. Firms issue longer-term debt when supply uncertainty among bond investors is high. Moreover, we find that this effect of supply uncertainty on the firm's debt maturity decision is driven by the supply uncertainty in the short-maturity category.

7. Conclusion

We examine the effects of capital supply uncertainty of the firm's bond investor base on the capital structure of the firm. We exploit a novel data set of institutional investors' quarterly bond holdings between 1998–2005 to examine whether supply uncertainty of the firm's bond investor bases affects the firm's financing decisions, leverage, and its debt maturity choice.

We posit that bond investors are non-transient and heterogeneous, and the supply of capital is not perfectly elastic in the short run. Subsequently, the higher the supply uncertainty of the firm's bond investors, the less the firm relies on bond financing, and the lower its leverage. We provide evidence in support of this hypothesis by showing that an investor base characterized by high capital supply uncertainty is related to lower leverage, a lower probability of issuing bonds, and a higher probability of issuing equity and borrowing from banks. We take a multi-pronged approach to address potential endogeneity issues and show that these results are robust to IV model estimations, alternative measures of supply uncertainty, a placebo test, and inclusion of firm fixed effects.

We also argue that bond financing is an especially unreliable source of financing when the firm's investor base has high capital supply uncertainty *and* is poorly diversified. In contrast, the limiting effect of supply uncertainty should be mitigated if the investor base is diversified and shocks to investors are not highly correlated. We provide evidence in support of this second hypothesis by showing that the impact

Table 13
Supply uncertainty and the firm's debt maturity.

This table presents the estimation results of the firm's debt maturity choice model. For columns 1–4,the dependent variable is a dummy taking the value of one if firm *i* issues long-maturity debt (longer than five years) in year *t* and zero if it issues short-maturity debt (five years or shorter); for columns 5–8, the dependent variable is the weighted-average (weighted by par amount) maturity of the debt issued by firm *i* in year *t*. $Turnover(maturity\text{-}weighted)_{i,t-1}$ is the maturity-weighted turnover across all the bonds of an issuer where the weight for each bond is 1/time-to-maturity. For each rating category, *Turnover (short)* is defined as the value-weighted average turnover across all investors with holdings in short-term bonds (maturity of less than three years). *Turnover(long)* is defined similarly for bonds with maturity of more than five years. To address the potential endogeneity of debt issuancechoice, we run a first-stage regression (unreported) of debt issuance choice probit model and include the inverse Mills'ratio (Heckman's lambda) in the second-stage regression (reported below). All of the specifications include year-, industry-, location-, and credit rating dummies. The symbols *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively, using heteroskedasticity-robust standard errors with *t*-statistics given in parentheses. See Appendix A for variable definitions.

	Probitregression(long-term debt dummy)				Tobitregression(debt maturity)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Turnover	0.81**				0.95			
	(2.00)				(1.22)			
Turnover (maturity-weighted)		1.25***				1.39*		
		(3.10)				(1.84)		
Turnover (short)			5.56***	5.06***			10.07***	8.63**
			(3.03)	(2.62)			(2.89)	(2.43)
Turnover (long)				2.09				5.88
				(0.87)				(1.22)
Bond flow	−0.30	−0.33	−0.27	−0.30	−1.18*	−1.20*	−1.07*	−1.14*
	(−0.80)	(−0.89)	(−0.75)	(−0.83)	(−1.75)	(−1.78)	(−1.71)	(−1.75)
Bond-to-corporate debt ratio	0.19	0.16	0.10	0.10	0.70	0.70	0.61	0.61
	(0.80)	(0.70)	(0.43)	(0.42)	(1.56)	(1.56)	(1.51)	(1.45)
Stock turnover	0.03	0.09	0.13	0.11	−1.90	−1.92	−2.11	−2.17
	(0.03)	(0.10)	(0.14)	(0.12)	(−1.11)	(−1.13)	(−1.19)	(−1.19)
Stock flow	3.78	3.51	3.92	4.00*	8.23*	8.26*	8.57*	8.75*
	(1.57)	(1.46)	(1.62)	(1.66)	(1.75)	(1.76)	(1.94)	(1.91)
Stock holding fraction	0.29	0.28	0.31	0.31	0.46	0.46	0.49	0.51
	(1.24)	(1.20)	(1.28)	(1.31)	(1.01)	(1.02)	(1.01)	(1.01)
Abnormal return	0.08	0.08	0.07	0.07	0.10	0.09	0.09	0.08
	(0.63)	(0.66)	(0.58)	(0.57)	(0.42)	(0.38)	(0.38)	(0.34)
Amihud's illiquidity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(1.10)	(1.03)	(0.78)	(0.76)	(0.62)	(0.55)	(0.19)	(0.14)
Stock return volatility	−1.36	−1.39	−1.23	−1.16	−3.38*	−3.27*	−3.19*	−2.98
	(−1.33)	(−1.35)	(−1.20)	(−1.12)	(−1.85)	(−1.78)	(−1.79)	(−1.61)
Asset tangibility	0.27	0.31	0.22	0.22	1.00	1.02	0.96	0.96
	(0.79)	(0.90)	(0.62)	(0.63)	(1.50)	(1.52)	(1.38)	(1.33)
Asset size	−0.03	−0.03	−0.03	−0.04	−0.13	−0.14	−0.14	−0.16
	(−0.31)	(−0.29)	(−0.31)	(−0.39)	(−0.70)	(−0.73)	(−0.88)	(−0.97)
Profitability	0.58	0.59	0.84	0.83	2.64	2.60	2.84*	2.87*
	(0.62)	(0.63)	(0.89)	(0.89)	(1.63)	(1.61)	(1.84)	(1.81)
R&D	0.55	0.87	0.84	0.98	0.52	0.66	0.85	1.24
	(0.21)	(0.32)	(0.31)	(0.36)	(0.12)	(0.15)	(0.22)	(0.31)
R&D dummy	0.13	0.13	0.13	0.13	0.33	0.31	0.32	0.31
	(1.18)	(1.15)	(1.20)	(1.17)	(1.57)	(1.52)	(1.60)	(1.51)
Altman's *z*-score	0.05	0.04	0.04	0.04	0.13	0.13	0.12	0.12
	(0.60)	(0.53)	(0.45)	(0.49)	(0.84)	(0.85)	(0.79)	(0.80)
Asset maturity	−0.00	−0.00	−0.00	−0.00	0.00	0.00	−0.00	−0.00
	(−0.11)	(−0.05)	(−0.21)	(−0.23)	(0.08)	(0.16)	(−0.04)	(−0.04)
Capital expenditure	−0.21	−0.42	−0.06	−0.12	−0.66	−0.77	−0.46	−0.64
	(−0.18)	(−0.36)	(−0.05)	(−0.10)	(−0.28)	(−0.33)	(−0.19)	(−0.26)
Market-to-book	−0.03	−0.03	−0.04	−0.04	−0.04	−0.04	−0.05	−0.05
	(−0.45)	(−0.39)	(−0.58)	(−0.57)	(−0.37)	(−0.34)	(−0.33)	(−0.30)
Book leverage	1.03***	1.02***	1.07***	1.06***	1.75**	1.73**	1.77**	1.72**
	(2.77)	(2.75)	(2.87)	(2.83)	(2.55)	(2.52)	(2.60)	(2.42)
Inverse Mills'ratio	1.05*	1.00*	1.08*	1.15*	2.05	2.10	2.21**	2.38***
	(1.73)	(1.65)	(1.73)	(1.84)	(1.54)	(1.57)	(2.01)	(2.08)
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Location, rating, and industry FE	Y	Y	Y	Y	Y	Y	Y	Y
Number of observations	1317	1317	1317	1317	1317	1317	1317	1317

of supply uncertainty on the firm's financing policy is entirely driven by firms with highly concentrated bond investor bases. We also find that the results hold only for firms in high-growth/ low-profitability industries.

Finally, we argue that firms respond to an increase in capital supply uncertainty by adjusting the maturity of debt they issue. We provide evidence in support of this third hypothesis by examining how supply uncertainty affects the firm's choice of debt maturity. Firms are more likely to issue long-maturity debt when supply uncertainty among bond investors is high. Moreover, we find that this effect of supply uncertainty on the firm's debt maturity decision is driven by the supply uncertainty in the short-maturity category.

Overall, our evidence shows that, contrary to the standard treatment in the theory, the supply uncertainty of the firm's bond investor base is an important determinant of the firm's financing policy. Firms are rationally sensitive to their bond investors' supply uncertainty in making their financing decisions and leverage choice, relying less on bond financing when their investor bases consist primarily of high-turnover or high-volatility investors and therefore unreliable future funding sources. This effect is not uniformly distributed among firms. Rather, supply uncertainty sensitivity of the firm is positively related to the concentration of their investor bases. Thus, those that respond most strongly to these future funding risk factors are firms with investor bases that exhibit strong local bias, high geographic clustering, or high herding propensity. Moreover, the firms' maturity choice is also a function of their investors' supply uncertainty: Firms lengthen the maturity of bonds they issue when faced with high supply uncertainty, especially in the short-maturity bond category.

Appendix A. Variable definitions

Abnormal return: Cumulative abnormal return measured relative to a CRSP value-weighted market model regression and estimated using the second year prior to the forecast year.

Altman's *Z*-score: 3.3 × pre-tax income (data170)+sales (data12)+1.4 × retained earnings (data36)+1.2 × (current assets (data4)−current liabilities (data5))/book assets (data6).

Amihud's illiquidity: The annual average of 1000 × $\sqrt{|R_{i,t}|/DVol_{i,t}}$ where $R_{i,t}$ is the return and $DVil_{i,t}$ is the dollar volume of stock *i* at day *t*. Downloaded from Joel Hasbrouck's website.

Asset maturity: Gross Property, Plant, and Equipment (PPE) (data7)/depreciation and amortization (data14).

Asset size: log(sales) (data12).

Asset tangibility: net PPE (data8)/book assets (data6).

Bond flow: Let S_i denote the set of investors holding bond *i*, and let $R_{i,t}$ and $V_{i,j,t}$ denote the return and the par amount of bond *i* held by investor *j* at quarter *t*. The bond flow is then

$$\sum_{j=1}^{S_i}(V_{i,j,t}-V_{i,j,t-1}(1+R_{i,t}))/\sum_{j=1}^{S_i}V_{i,j,t-1}. \quad \text{(A1)}$$

Book equity: total assets (data6) minus total liabilities [data181] and preferred stock [data10] plus deferred taxes [data35] and convertible debt [data79] (following Baker and Wurgler, 2000).

Book leverage: total debt/book assets (data6).

Capital expenditure: Capital expenditures (data128)/book assets (data6).

Credit rating: senior long-term debt rating (data280). We further synthesize data280 into ten rating categories: AAA, AA, A, BBB, BB, B, CCC, CC, C, NR (not rated).

Credit Rating Dummies: One dummy variable for each rating category from AAA to NR. For example, $AAA\ dummy_{i,t}$= one if $credit\ rating_{i,t}$=AAA, and zero otherwise.

High local mutual fund fraction dummy: For each firm-quarter, we locate a (longitude−5, longitude+5), (latitude −5, latitude+5) region, then find all the mutual funds, pension funds, and insurance companies located in the region. We then calculate the total bond holdings of each rating category (above investment-grade/below investment-grade/non-rated) by each fund and the fund-firm distance. Then we define weight: $w_{ij}=(1/d_{ij})/(\sum(1/d_{ij}))$. Suppose the firm belongs to rating category *R*, then the variable is defined as:

$$Frac_i=\frac{\Sigma_{j\in MUT}w_{ij}H_{jR}}{\Sigma_{j\in MUT}w_{ij}H_{jR}+\Sigma_{j\in INS}w_{ij}H_{jR}+\Sigma_{j\in PEN}w_{ij}H_{jR}}, \quad \text{(A2)}$$

where *MUT*, *INS*, and *PEN* refer to mutual funds, insurance companies and pension funds. Then "High local mutual fund fraction dummy" equals one if *Frac* is above the sample median and zero otherwise.

Industry book leverage: Median book leverage at four-digit SIC level.

Institutional bond-to-corporate debt ratio: The total sum of the par amounts of bond *i* held by all institutional investors included in the Lipper database divided by the total debt outstanding for the issuer of bond *i* in a given year.

Local fund turnover: For each firm-quarter, we first locate the (longitude−5, longitude+5), (latitude−3, latitude+3) region, then find all the mutual funds, pension funds, and insurance companies located in the region. The distance between firm *i* and fund *j* is defined as:

$$d_{ij}=\log(10+3963{*}a\cos(\sin(1\text{ at }1){*}\sin(1\text{ at }2) + \cos(1\text{ at }1){*}\cos(1\text{ at }2){*}\cos(\text{long2}-\text{long1}))).$$

Then we define weight: $w_{i,j}=(1/d_{i,j})/\Sigma_{ALL}(1/d_{i,j})$, and calculate the distance-weighted fund churn rate based on all the funds located at that region: $LocalTurn_i=\Sigma_j w_{ij}Churn_j$.

Location dummies: We divide the 50 U.S. states into seven areas: area1 (Northwest), area2 (West), area3 (Midwest), area4 (the Gulf states), area5 (East), area6 (South), and area7 (Hawaii and Alaska). We create a dummy variable for each one of them. For example, $Area1\ dummy_{i,(j,)\ t}$=one if the issuer of bond *i* (held by investor *j*) at time *t* is headquartered in the Northwest area, and zero otherwise.

Market value of assets: stock price (data199) ∗ shares outstanding (data25)+short term.

debt(data34)+long term debt(data9)+preferred stock liquidation value (data10)−deferred taxes and investment tax credits (data35).[69]

Market-to-book ratio: market value of assets/book assets (data 6).

Market leverage: total debt/market value of assets.

Profitability: operating income before depreciation (data13)/book assets (data6)

Research and development: R&D expenditures (data46)/book assets (data6). The missing values are replaced with 0.

[69] Following Lemmon and Roberts (2010).

R&D dummy: equals one if R&D expenditures (data46) is missing and zero otherwise.

Stock return volatility: 12-month rolling sample deviation of monthly stock returns.

Stock turnover: A firm's stock turnover is calculated in the same manner as Eq. (2). Investor-level equity portfolio information comes from CDA/Spectrum, a database of quarterly 13-F filings of money managers to the U.S. Securities and Exchange Commission.

Stock flow: A firm's stock flow is calculated in the same manner as Eq. (A1). Investor-level equity portfolio information comes from CDA/Spectrum.

Stock holding fraction: The total number of common shares of a given firm that is held by all the institutional investors included in the CDA/Spectrum database divided by the total number of shares outstanding (of the same firm).

Total debt: long term debt (data9)+short term debt (data34) (data#=Compustat data item number).

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