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The impact of joint participation on liquidity in equity and syndicated bank loan markets

Linda Allen [a], Aron A. Gottesman [b], Lin Peng [a,*]

[a] Zicklin School of Business, Baruch College, City University of New York, One Bernard Baruch Way, 10-225, New York, NY 10010, United States
[b] Lubin School of Business, Pace University, 1 Pace Plaza, New York, NY 10038, United States

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ABSTRACT

Market liquidity is impacted by the presence of financial intermediaries that are informed and active participants in both the equity and the syndicated bank loan markets, specifically informationally advantaged lead arrangers of syndicated bank loans that simultaneously act as equity market makers (dual market makers). Employing a two-stage procedure with instrumental variables, we identify the simultaneous equations model of liquidity and dual market maker decisions. We find that the presence of dual market makers improves the liquidity of the more competitive and transparent equity markets, but widens the spread in the less competitive over-the-counter loan market, particularly for small, informationally opaque firms.

1. Introduction

The glue that connects markets is the financial intermediary. In order to be considered a major player, a financial intermediary maintains a presence in all of the major financial markets in the world. Participating in multiple financial markets can be particularly lucrative if information obtained in one market is useful in other, related markets. For example, information about fundamental firm value obtained in debt and derivatives markets may be reusable in equity markets. Conversely, information about equity market order flow may be reusable in debt and derivatives markets. The reusability of information has motivated the potentially synergistic combination of commercial and investment

* Corresponding author. Fax: +1 646 312 3451.
E-mail addresses: Linda_Allen@baruch.cuny.edu (L. Allen), agottesman@pace.edu (A.A. Gottesman), lin.peng@baruch.cuny.edu (L. Peng).

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banking activities into large complex financial institutions. When information is used effectively, these institutions can be net liquidity providers to global financial markets. However, large complex financial institutions can sometimes blockade market liquidity, thereby reducing trading efficiency. Indeed, the crisis of 2007–2009 demonstrates the crucial role financial institutions play in the liquidity of these markets.

The gradual relaxation and the eventual repeal of the Glass-Steagall Act in 1999 expanded banking powers to include a broad range of banking, securities underwriting and insurance activities. However, there is a growing debate about whether the benefits of such expansions outweigh the costs.[1] Berger and Bouwman (2009) show that large banks contributed most to the creation of liquidity in the economy over the period from 1993 to 2003. However, this liquidity increase may have been obtained at the cost of financial market fragility, as the reach of global financial institutions contagiously spread risk throughout the financial system (highlighted by the financial crisis of 2007–2008).

In this paper, we examine how simultaneous trading by global financial institutions across financial markets impacts the liquidity and informational efficiency of asset prices across markets.[2] In particular, we focus on financial intermediaries that are informed and active participants in both the syndicated bank loan and the equity markets. We define dual market makers to be financial intermediaries that are simultaneously equity market makers as well as lead arrangers of bank loan syndicates. In our formulation, these dual market makers are among the most informed participants in the market, because they can extract information from both the syndicated loan market and the equity market. The lead arranger, in contrast to other loan syndicate participants, is typically a bank with a prior lending relationship with the borrower. In the course of a long-term banking relationship that includes the provision of a myriad of deposit, cash-management and lending services, the relationship bank gathers private information about the borrower. There is an extensive literature describing the private information generated in the course of a long-term bank-borrower relationship; see Boot (2000) for a survey of relationship lending. This private information advantage is most valuable for small borrowing firms. Small borrowing firms tend to be more informationally opaque than larger firms because they have fewer market makers, less analyst coverage, and tend to have greater information asymmetries.[3] By virtue of its access to this private information, the lead arranger screens the loan on behalf of all lenders in the syndicate.[4]

Moreover, as a result of concern about a potential lemons problem in the presence of these informational asymmetries, the lead arranger precommits to the other (less informed) syndicate members by holding a large portion of the loan until maturity.[5] The lead bank's stake (and the accounting requirement that this position is generally marked to market) therefore provides it with strong incentives for market making in the secondary loan market, as well as ongoing monitoring during the life

[1] For example, Benston (1990), Kroszner and Rajan (1994), Puri (1996,1999), Kanatas and Qi (2003), Schultz (2003), Saunders and Stover (2004), Allen et al. (2004), Chung and Cho (2005), Drucker and Puri (2005), Ljungqvist et al. (2006), Bharath et al. (2007), Bodnaruk et al. (2009), Madureira and Underwood (2008), and Keys et al. (2010).

[2] While we focus on the role of informed market makers on market liquidity and especially bid-ask spreads, common players across multiple markets or assets can also cause contagion (for example, Allen and Gale, 2000; Kyle and Xiong, 2001, and Peng and Xiong, 2006), as well as commonality in liquidity (Coughenour and Saad, 2004) through various mechanisms.

[3] We are indebted to an anonymous referee who pointed out the importance of small firms in our analysis.

[4] During the entire term of the syndicated bank loan, the lead arranger must share all material, non-public information releases with all other members of the syndicate. Although this may reduce the lead arranger's informational advantage (vis-à-vis the other syndicate members), it does not eliminate it, since the lead arranger is not required to reveal information gathered prior to the loan's origination in the course of a long standing banking relationship. Moreover, the lead arranger's superior knowledge of the borrower's activities may facilitate analysis of the information released to the syndicate, thereby preserving the lead arranger's informational advantage. See Ivashina (2009) for a discussion of information asymmetries between the lead arranger and participants in loan syndications. Relationship banks obtain this private information about their customers by observing a history of customer information such as the flow of funds through customer checking accounts, past repayment history, customer use of commercial banking products such as letters of credit and firm hedging activities. For example, Mester et al. (2002) find that banks can use checking account activity to monitor borrower creditworthiness on a real time basis. Thus, lead arrangers tend to have informational advantages over other less informed, members of the loan syndicate.

[5] Allen and Gottesman (2006) show that the average share of the syndicated bank loan facility held by the lead arranger is 27% (median 16%). In contrast, the average share of syndicate participants is less than 3% (median 1.88%).

of the loan. Gande and Saunders (2006) show that monitoring and secondary market activity are complements in the syndicated loan market, such that the relationship bank profits from its informational advantage in all aspects of its role as lead arranger – monitoring the borrower, managing the syndicate, and providing liquidity to the secondary market when needed. Indeed, it is understood that the lead arranger will manage secondary market trading, for example, by facilitating price discovery or by enforcing covenants requiring prior consent by the lead arranger (and/or the borrower) for secondary market transactions.[6] Given the repetitive nature of the syndication process, the failure of a lead arranger to provide market making services in the secondary loan market when required would likely impair that bank's ability to create syndicates in the future.

The financial intermediary that syndicated a bank loan may also have incentives to make markets in the borrowing company's stock. While the private information generated from the loan market will impact the bank's trading activity in the equity market, the dual market maker can also extract valuable information from the equity market order flow that is not shared by other traders in the loan market. Equity market making may produce information that complements the information about fundamental firm value obtained from the loan market. That is, while the loan syndicate has more micro-level information about the firm's fundamental value, equity market traders may have more macro-level information, e.g., regarding the general macroeconomic environment that is relevant to the firm, industry growth perspectives, the company's competitors, suppliers and the demand for its products.

It is therefore reasonable to assume that the lead arranger of a bank loan syndicate may have private information about a publicly traded borrower that a random equity market maker may not have, in part due to the depository and lending relationship that the lead arranger has with the borrower. Symmetrically, an equity market maker may have information about the firm that bank loan syndicate leaders without any presence in equity markets do not have. The financial intermediary's presence in both the equity and the syndicated loan markets allows them to collect information from both markets and subsequently profit from trading in both markets. We further expect that the effect of the financial intermediary's presence to be strongest for small borrowers that have more information asymmetry, less analyst following, fewer market makers, and are less transparent.

The identification of dual market makers as traders with an information advantage allows us to investigate the role of informed financial institutions on market liquidity and the informativeness of asset prices. We hypothesize that the presence of a "super-informed" dual market maker impacts liquidity and the price discovery process in both the equity and syndicated bank loan markets. However, the impact of the dual market maker on each market can be very different, depending on the nature of the market.

In this paper, we hypothesize that the presence of dual market makers decreases the bid-ask spread in the equity market (*liquidity enhancement effect*), and increases the spread in the syndicated loan market (*negative liquidity effect*). We develop this fundamental hypothesis in three stages:

1. Dual market makers are "super informed." As the lead arranger in a syndicated bank loan, the dual market maker has private information about the firm obtained in the course of a depository and lending relationship. As an equity market maker, the dual market maker has superior information about order flow and industry level macro-information. The dual market maker's informational advantage should be less significant for large, informationally transparent firms.
2. Equity markets are more transparent, more competitive, and have more liquidity traders than the syndicated bank loan market, which is opaque and limited to institutional participants trading over-the-counter.

[6] Fight's practitioner manual (2004, p. 37) states that the syndicated bank loan agent's duties include "any changes in participations made through the secondary market," i.e., loan market making activities. Pyles and Mullineax (2008) show that loan covenants are most actively monitored for small, informationally opaque borrowers in order to reduce the likelihood of strategic default, increase the chance of successful restructuring in the event of financial distress and foster relationships among syndicate members. Thus, the lead arranger has an incentive to manage the composition of the syndicate (both upon initiation of the deal and in the secondary market) so as to prevent failed restructurings or strategic default, which can harm the lead bank's reputation. Consistent with this reputation effect, Drucker and Puri (2009) show that loans originated by top-10 market share banks tend to be more likely to trade in secondary markets. In addition, they find that relationships are more durable in the presence of secondary market loan trading.

3. Because of the differing structures of syndicated bank loan markets and equity markets, the presence of a dual market maker will increase spreads in the syndicated bank loan market and decrease spreads in the equity market, most substantially for smaller firms.

However, the presence of a dual market maker is not exogenously determined. Loan syndicate arrangers will have a greater incentive to make markets in equity when the profit opportunities are high. This will be the case when there is a large and active equity market with profitable spread levels, and when the degree of information asymmetry in the equity market is large. Formal tests for endogeneity reject the null hypothesis of no endogeneity and affirm the need to control for the endogenous presence of dual market makers. We explicitly model the presence of a dual market maker in the empirical analysis by using a simultaneous equation model.

Specifically, we estimate the impact of the dual market maker's presence on market liquidity using a two-stage procedure that permits simultaneous multivariate estimation of one continuous dependent variable and one discrete dependent variable, corresponding to the technique detailed in Maddala (1983). We employ the Sargen test, the Anderson underidentification test, the test proposed by Bound et al. (1995) and Staiger and Stock (1997), and the Stock–Yogo (2005) test to confirm the selection of our instruments and the identification of our equation systems.

After accounting for the endogeneity of the dual market maker decision, we find a significant increase in equity market liquidity in the presence of dual market makers. The presence of a dual market maker reduced equity spreads by 39.5 basis points, about 35% of the mean equity spread, consistent with the *liquidity enhancement effect* for the more competitive equity market. In contrast, we find a significant increase in loan spreads in the presence of dual market makers, with an increase of 25.3 basis points (21% of the mean loan spread), consistent with the *negative liquidity effect* for the less competitive loan market. These effects are only significant for smaller firm borrowers/issuers; for larger firms, the effects are insignificant. These results are consistent with the hypothesis that the marginal effect of dual market presence is greater for firms with greater information asymmetry and less transparency. In addition, we find that the lead arranger of a syndicated bank loan is more likely to also be an equity market maker when the profit opportunity of market making is high. This occurs when the equity market is large, when the dual market maker has a greater informational advantage over other equity market makers, and when the dual market maker has more market power.

Our model focuses on the lead arranger's decision to make markets in the equity market rather than the equity market maker's decision to be a lead arranger in the syndicated loan market. This is because it is well established in both the academic literature and among practitioners that the borrower typically chooses the lead arranger on the basis of a prior banking relationship (see Ivashina (2009), Allen and Gottesman (2006) and Dennis and Mullineaux (2000)). The syndicate is then formed by the lead arranger. This is consistent with our hypothesis in that it is the private information about fundamental firm value obtained in the course of relationship banking that is the source of the lead arranger's informational advantage. In contrast, the equity market maker has superior information about market liquidity and order flow, but not necessarily about fundamental firm value.

The paper is organized as follows. Hypothesis development, the sample selection and data description appear in Section 2. Section 3 lays out the empirical methodology and the results of the empirical tests on the impact of the presence of a dual market maker on liquidity in the equity and loan markets. Section 4 examines the robustness of our results, including various subsample analyses and employing a propensity score matching methodology. Section 5 offers policy implications and conclusions.

2. Hypothesis development, sample selection and variable descriptions

2.1. Hypothesis development

Equity markets are among the most transparent and liquid of all financial markets, with price discovery processes that are very competitive. In contrast, syndicated bank loan markets are over-the-counter and opaque – there is no firm quoted price and no published "tape" of transaction prices. Participation in this market is limited to only a subset of institutional traders.

Several theoretical models argue that improved transparency reduces transaction cost. Pagano and Röell (1996) show that liquidity providers are better able to infer the degree of informed trading in a more transparent market, thereby reducing informational rents and transaction costs. Naik et al. (1999) show that improved transparency in a dealer market can improve risk sharing, thereby decreasing the inventory cost component of the bid-ask spread. Extending Biais (1993), Yin (2005) shows that quote transparency eliminates customers' search cost, which results in more competition and lower bid-ask spreads. Recent empirical studies from corporate and municipal bond markets, including Bessembinder and Maxwell (2008), Harris and Piwowar (2006), Edwards et al. (2007), Green et al. (2007), Goldstein et al. (2007), and Biais and Green (2007) all demonstrate that better transparency is associated with smaller execution costs.

In our setting, the lead arranger of the syndicated loan may choose to provide market making services in equity markets if it is profitable to do so. However, in transparent and competitive equity markets, the informational rents that can be extracted are smaller than those in opaque and less competitive markets, such as the syndicated bank loan market. Therefore, equity market makers have to provide price improvement in order to attract order flows.[7] Since dual market makers are "super-informed," they can be more aggressive in their quotes as the degree of information asymmetry they face is smaller. Their ability to set the price more efficiently allows them to be natural liquidity providers in equity markets. We hypothesize, therefore, that transparency and competition in equity markets lead to an improvement in information efficiency and a reduction in the equity bid-ask spread in the presence of a dual market maker. We expect this effect to be stronger for small firms with less analyst coverage and public information production.

On the contrary, the dual market maker faces much less competition in the opaque syndicated loan market. Therefore, the presence of informed traders with excessive market power may increase the adverse selection problem and widen spreads, since market makers are under less competitive pressure to use spreads to attract order flow in the loan market. In the presence of a "super-informed" trader, less informed market makers tend to react defensively and are reluctant to provide liquidity. Thus, we hypothesize that the participation of the more-informed dual market maker will widen bid-ask spreads in the syndicated bank loan market.

Another reason that the added presence of the dual market maker lowers spreads in equity markets but not in loan markets could simply be differences in the number of market makers. As modeled by Biais et al. (2000), positive mark-ups charged by the liquidity suppliers decrease with the number of competitors. Wahal (1997) shows that the entry of market makers on Nasdaq leads to declines in spreads. Goldstein and Nelling (1999) empirically show that the number of market makers and spreads are interrelated. The entrance of the dual market maker increases the number of equity market makers (thereby lowering spreads), but not the number of loan market makers since the lead arranger is expected to make markets for the syndicated loans irrespective of their activities in the stock market. That is, controlling for the firm and loan characteristics, the number of loan market makers does not change whether the lead arranger is also an equity market maker (dual market maker) or not.

On another dimension, there are a large number of liquidity traders in the equity markets, but not in institutional syndicated loan markets.[8] As shown in classical market microstructure models

[7] Bessembinder (2003) shows that off-NYSE liquidity providers use competitive quotations to attract order flow, especially when increased market share is more likely to be more profitable (i.e., when existing spreads are wide and when markets are active). There is a related question why the other uninformed equity market makers cannot simply follow the informed market maker and therefore compete away his profit. Calcagno and Lovo (2006) model the strategic interaction between informed and uninformed market makers and show that the informed market maker can adopt mixed-strategies to affect and possibly mislead the uninformed market makers' beliefs. As a result, even with publicly observable quotes, the informed market maker's expected payoff is positive.

[8] An example of a liquidity trader in the syndicated bank loan market could be prime loan mutual funds, which may be forced to sell loan syndications because of fund outflows. There are relatively few liquidity traders because all traders in the loan market are institutional traders, although they may not be as informed as the lead arranger. Thus, institutional traders are disadvantaged by the higher loan market bid/ask spreads in the presence of dual market makers. Nandy and Shao (2010) demonstrate that tranches traded by non-lead institutional loan investors tend to offer higher coupon yields (all-in-spreads over LIBOR), possibly compensating less informed investors for this informational disadvantage.

(Grossman and Stiglitz, 1980; Glosten and Milgrom, 1985; Kyle, 1985, among others), the number of uninformed liquidity traders can also affect the depth of the market. Everything else equal, the market makers in a market with more liquidity traders are more willing to quote a narrower spread, since potentially increased losses to informed traders are offset by increased profits from liquidity traders. Since there are proportionally more liquidity traders in equity markets as compared to syndicated bank loan markets, dual market makers may quote low spreads in equity markets, but set relatively high loan spreads in loan markets. These effects are exacerbated for informationally opaque, small firms.

2.2. Sample selection and descriptive statistics

We obtain data on pricing in both the equity and syndicated bank loan markets. Our initial sample is obtained from the Loan Pricing Corporation (LPC) and consists of 129,172 daily secondary loan market quotations, observed on a weekly basis, for which at least two quotes are available for the date of the observation during the sample period January 1999 through May 2003. These observations are associated with 1621 individual loan facilities to 763 individual borrowers. The database provides the mean bid and mean ask quotation for each observation.[9] The number of loan quotes for the day of each observation, LOANNBA, is calculated as the sum of the bid and ask quotations for each loan observation. The loan return, LOANRETURN, is calculated as the weekly loan return, where the average of the mean bid and mean ask quotation (denoted the mean of the mean) is a proxy for loan transaction price. The relative loan spread, LOANSPREAD, is calculated as the difference between the mean bid and the mean ask divided by the transaction price proxy.

Using primary loan market data from the LPC DealScan database, we extract control variables associated with the given facility at loan initiation. Dennis et al. (2000) show that collateral is an important loan contracting feature. Thus, we define SECURED as a dummy variable that is equal to one if the loan is secured, and zero otherwise. RATEAISD is the basis point loan spread at initiation over LIBOR. FACILITYSIZE (ln(FACILITYSIZE)) is the (logarithmic value of the) facility size at initiation, measured in millions of dollars. NUMBSYN (ln(NUMBSYN)) is the (logarithmic value of the) number of syndicate members at initiation. LEADSHAREOFMARKET is the lead arranger's share of the syndicated loan market (in percentage), estimated using the LPC historical league tables.

We next merge the above sample with CRSP by comparing the borrower's ticker and name provided by LPC with the tickers and names specified on CRSP. EQUITYRETURN is the 1-week equity return, calculated using the equity price standardized by the cumulative factor to adjust for splits and dividends. ln(MARKETVALUE) is the logarithmic market value of the borrower, where market value is defined as the number of shares outstanding multiplied by the equity price on the day of the observation. A return volatility measure based on monthly equity returns, designated EQUITYVOLATILITY, is calculated for observations for which at least 17 of the previous 24 months of return data are available.

We obtain a number of additional control variables from COMPUSTAT's North America Fundamental Annual dataset for the end of the fiscal year that precedes the weekly secondary loan market observation. LEVERAGE is the borrower's total debt divided by total assets. INCOMETOA is the borrower's operating income before depreciation divided by total assets. EPS is earnings per share. TANGIBLE is gross property, plant and equipment divided by the firm's total assets. FRENCH1–12 are indicator variables that are equal to unity if the firm's industry, as defined by the firm's 4-digit SIC, falls into one of 12 categories as categorized by Professor Kenneth French.

We define a dual market maker, DUALMM, as a dummy variable equal to one if on the date of the observation specified by the LPC secondary loan market database, the loan's lead arranger was an

[9] There is no "tape" in the syndicated bank loan market that records transaction prices. LPC data consist of quotations obtained from market makers (although the identity of the quoting market maker and individual quotes are not provided). LPC's internal studies suggest that the average of the mean bid and ask quotes is very close to actual transaction prices for a subsample of par loan transactions. In contrast, transaction prices for distressed loans may trade outside of the bid/ask spread. Other recent papers that have used the LPC database include: Bharath et al. (2007) and Sufi (2007). Other papers that use the secondary market database are Altman et al. (2010) and Gande and Saunders (2006).

Table 1
Breakdown of the number of secondary loan market quotes, loan facilities, and borrowers during stages of the sample construction.

	Secondary loan market quotes	Loan facilities	Borrowers
(1) Initial sample	129,172	1621	763
(2) Data in (1) for which variables based on CRSP and COMPUSTAT data are available	46,588	688	290
(3) Data in (2) for which variables based on TAQ data are available	25,620	423	181
(4) Data in (3) for which variables using LPC data can be constructed (final sample)	22,826	384	165

equity market maker on Nasdaq, as defined by the TAQ database's MMID.[10] A syndicate member is considered to be a lead arranger as long as the LPC DealScan database specifies a role designation other than "participant." Thus, the lead arranger can have the legal titles of administrative agent, documentation agent, arranger, lead manager, etc. EQUITYSPREAD is the time-weighted relative equity spread, where the relative equity spread is calculated as the national best bid and offer (NBBO) spread divided by the average of the best bid and the best ask, measured in percentages. The NBBO is the best bid and offer at each moment in time, aggregated from NYSE, NASDAQ and AMEX. EQUITYINDEXRETURN is the weekly return on the S&P 500 Composite Index, extracted from CRSP. LOANINDEXRETURN is the weekly return on the S&P/LSTA syndicated bank loan index.

Using return and accounting data from COMPUSTAT and CRSP, we calculate the implied probability of default (denoted PROBDEFAULT) using a Merton options-theoretic model (see Allen and Peristiani (2007)). Since large changes in default risk may trigger uncertainty about the loan's future value and thereby impact liquidity, we also define two variables, DIFPROBDEFAULT and LAGDIFPROBDEFAULT that measure the 1-week change in the implied default probability for weeks t and $t-1$.

After eliminating the observations for which the key variables are missing, we are left with 22,826 secondary market observations, associated with 384 individual loan facilities to 165 individual borrowers. Table 1 shows the construction of our sample. Descriptive statistics are provided in Table 2. More than 22% of our observations have dual market makers that simultaneously arrange loan syndications and act as equity market makers. Panel A of Table 2 also provides descriptive statistics for the sample segmented by the presence of a dual market maker. This segmentation illustrates our main results: i.e., when there is a dual market maker, loan spreads are higher and equity spreads lower. Moreover, dual market maker loans have more bid/ask quotes, higher lead arranger share of the market, larger lead banks (by market capitalization) and more volatility in equity markets. Panel A of Table 2 also shows that dual market maker transactions have higher loan all-in-spreads, larger facility size and more members of the syndicate, in addition to borrowers with more leverage and less tangible assets.

One might argue that the banks that make markets in both the syndicated loan and the equity markets are likely to be large, more prestigious and more established, and their presence itself would reduce equity spreads. In addition, larger borrowers with greater stock market capitalization are more likely to attract dual market makers. Indeed, Panel A of Table 2 shows that the market capitalization of both borrowers and lead arrangers is significantly (t-test significant at the 1% level) greater when a dual market maker is present. Thus, in Panel B, we present comparative statics by both borrowing firm size and by bank size. We break our sample into two firm size subsamples, large and small, based on the median value of the market capitalization of the borrowing firms ($1154.56 million dollars). Table 2, Panel B shows that small firms have both higher equity and loan spreads, as well as fewer dual

[10] In order to construct strict tests of our hypotheses, we restricted our definition of dual market maker status in two ways: (1) we only include those financial intermediaries that are both lead arrangers and equity market makers on the same day and (2) we exclude specialists on the NYSE. This definition may exclude some cases where the dual market maker does not immediately trade on information, but instead trades in subsequent days. To test for this, we examine whether the dual market maker status changes from week to week, and find that in 99.14% of the observations in our sample the dual market maker status does not change from week to week. Moreover, when we include specialists in our definition of dual market makers (see Table 7, column 3), our results are actually strengthened, consistent with a greater dual market maker effect for larger, more established banks.

Table 2
Descriptive statistics. Loan and equity market variables, variable descriptions, number of observations, and mean are reported for a sample of syndicated bank loans that had at least two quotes from loan dealers on a given date between January 1999 and May 2003. The mean values for each variable are reported separately for subsamples consisting of observations for which DUALMM is equal to one and zero, respectively. The mean values for each variable are reported separately for subsamples consisting of the top 5 banks (by market capitalization, denoted large banks) and for all other banks. The results of *t*-tests of the differences across both sets of subsamples are also reported. Panel A presents the full sample statistics. Panel B present results for subsamples based on firm size (based on the median value of the market capitalization of the borrowers as defined in Section 2) and based on the size of the lead arranger where the top five banks (in terms of market capitalization) are designated as large and the remaining 30 as small.

Variable	Variable description	Number	Mean	Mean, yes DUALMM	Mean, no DUALMM	*t*-Test
Panel A						
DUALMM	Dual market maker dummy	22,826	0.2244	1.0000	0.0000	
LOANSPREAD	Relative loan spread (%)	22,826	1.2109	1.5472	1.1135	−13.0300***
LOANRETURN	Loan return	22,826	−0.0001	0.0001	−0.0001	−1.4800
LOANINDEXRETURN	Loan index return	22,698	−0.0002	−0.0003	−0.0001	3.6800***
LOANNBA	Sum of loan bid and ask quotations	22,826	8.0191	9.7439	7.5200	−25.3800***
LEADSHAREOFMARKET	Lead arranger's market share (%)	19,618	17.1927	25.3504	14.3095	−50.6800***
EQUITYSPREAD	Relative equity spread (%)	22,826	1.1139	0.8240	1.1977	10.3100***
EQUITYRETURN	Equity return	22,826	0.0027	0.0019	0.0029	0.6600
EQUITYINDEXRETURN	Equity index return	22,826	−0.0024	−0.0047	−0.0017	6.1200***
EQUITYVOLATILITY	Monthly equity volatility	21,602	0.1599	0.1740	0.1556	−17.3000***
PROBDEFAULT	Implied probability of default	22,826	0.0367	0.0368	0.0367	−0.0600
DIFPROBDEFAULT	Change in implied probability of default	21,826	0.0004	0.0003	0.0004	0.4500
LAGDIFPROBDEFAULT	Lagged change in implied probability of default	20,726	0.0004	0.0003	0.0004	0.7200
SECURED	Collateralization dummy	22,826	0.8408	0.8846	0.8282	−9.7500***
RATEAISD	Basis point loan spread at initiation	22,826	266.0756	269.8461	264.9845	−2.9000***
FACILITYSIZE	Loan facility size (Millions $)	22,826	479.3394	560.0019	455.9968	−11.3500***
NUMBSYN	Number of syndicate members at initiation	22,595	17.5789	19.5157	17.0110	−10.7900***
LEVERAGE	Total debt/total assets	22,826	0.5277	0.5360	0.5253	−3.2100***
INCOMETOA	Operating income before depreciation/ total assets	21,645	0.1264	0.1409	0.1219	−15.1300***
EPS	Earnings per share	22,771	0.2791	0.4159	0.2397	−1.7000*
TANGIBLE	Gross property, plant and equipment/total assets	21,742	0.5002	0.4726	0.5085	6.7800***
MARKETVALUE	Borrower market value (Million $)	22,826	2704.18	3106.94	2587.64	−4.9500***
LEADMARKETVALUE	Lead arranger market value (Million $)	19,089	72,827.23	77,624.05	71,172.53	−7.9300***

Variable	Mean, large banks	Mean, small banks	*t*-Test	Mean, large borrowers	Mean, small borrowers	*t*-Test
Panel B						
DUALMM	0.2903	0.2546	−2.5139**	0.3045	0.1444	−29.5319***
LOANSPREAD	1.6171	1.2102	−5.5542***	0.9012	1.5206	22.4677***

(*continued on next page*)

Table 2 (*continued*)

Variable	Mean, large banks	Mean, small banks	*t*-Test	Mean, large borrowers	Mean, small borrowers	*t*-Test
LOANRETURN	−0.0020	0.0000	5.9452***	0.0002	−0.0003	−3.7261***
LOANINDEXRETURN	−0.0003	−0.0001	1.3491	−0.0001	−0.0003	−5.1189***
LOANNBA	7.3894	8.3999	5.2594***	9.1163	6.9219	−30.1852***
LEADSHAREOFMARKET	16.8829	18.2401	2.9624***	17.5642	16.7986	−3.7610***
EQUITYSPREAD	1.6763	0.9448	−11.7486***	0.3957	1.8321	49.9070***
EQUITYRETURN	−0.0061	0.0038	3.1494***	0.0062	−0.0008	−5.3713***
EQUITYINDEXRETURN	−0.0003	−0.0025	−2.2004**	−0.0029	−0.0019	2.4655**
EQUITYVOLATILITY	0.1797	0.1575	−10.2424***	0.1488	0.1713	25.0302***
PROBDEFAULT	0.0547	0.0332	−7.1875***	0.0164	0.0570	32.3285***
DIFPROBDEFAULT	0.0020	0.0002	−4.5139***	−0.0001	0.0009	6.0655***
LAGDIFPROBDEFAULT	0.0021	0.0003	−4.3590***	−0.0001	0.0010	6.6026***
SECURED	0.7508	0.8771	11.6133***	0.7958	0.8858	18.7228***
RATEAISD	268.2558	269.9621	0.5141	235.88	296.27	44.9578***
FACILITYSIZE	643.0390	477.5741	−9.9203***	663.50	295.18	−50.6764***
NUMBSYN	18.3764	18.1807	−0.3958	18.8058	16.3768	−12.5098***
LEVERAGE	0.4826	0.5216	5.9565***	0.4803	0.5750	34.6183***
INCOMETOA	0.0799	0.1264	22.0016***	0.1300	0.1226	−6.8801***
EPS	−1.6249	0.3727	8.6574***	0.7323	−0.1745	−10.4923***
TANGIBLE	0.3570	0.5126	15.4789***	0.4943	0.5063	2.6833***
MARKETVALUE	1496.08	2393.99	6.9148***	4888.22	520.15	−52.8474***
LEADMARKETVALUE	237,068.36	63,757.20	−175.1140***	70,867.82	74,922.80	5.6993***

market makers. We hypothesize that the effect of the dual market maker on liquidity is stronger for small firms than for large firms. Therefore, we not only include firm size as a control variable in our analysis, but also perform our analysis separately for subsamples of large and small firms.

Table 2, Panel B also shows descriptive statistics for two subsamples based on the size of the lead arranger, where the top five banks (in terms of market capitalization) are designated as "large" and the remaining 30 banks in our sample are designated as "small" (market capitalization below $107 billion). We find that large banks are significantly more likely to be dual market makers than smaller banks, significantly lowering both equity and loan spreads. To disentangle these bank and firm size effects, we perform our analysis on both the full and bank/firm size subsamples.

3. Empirical methodology and results

3.1. Single equation estimation results

Table 3 presents the results of our single equation estimation analysis of the syndicated bank loan market. Panel A contains the OLS regression results, using loan liquidity (LOANSPREAD) or equity liquidity (EQUITYSPREAD) as the dependent variable. Panel B presents the probit regressions with the dual market maker (DUALMM) as the dependent variable. Both sets contain Huber–White robust standard errors that allow for within firm correlation (the latter are shown in parentheses). We present results for the full sample, as well as for the firm size based subsample, large and small, based on the median value of the market capitalization of the borrowers as defined in Section 2.2. As shown in Table 3, Panel A, using the full sample, the coefficient of DUALMM is positive and statistically significant for loan market liquidity. This result seems to be consistent with the negative liquidity effect that the presence of a super informed dual market maker increases the loan spreads. Subsample results show that the effect is statistically significant (at the 5% level) for the small firm subsample only.

However, as suggested earlier, the OLS results could be misleading if the explanatory variable, DUALMM, is endogenous. Rather than reflecting the negative liquidity hypothesis, the OLS results may reflect the information asymmetries in the loan market. That is, if loan spreads are wider when information asymmetries are large, the lead arranger has a valuable information advantage based on access to private information obtained in the course of the banking relationship. This information

Table 3
Single regressions of loan (equity) market liquidity and dual market maker decision. In Panel A, we perform OLS regression of LOANSPREAD or EQUITYSPREAD on DUALMM. In Panel B, we perform Probit regression of DUALMM on LOANSPREAD or EQUITYSPREAD.The large and small firm subsamples are, based on the median value of the market capitalization of the borrowing firms as defined in Section 2.2. DUALMM is the dual market maker dummy. LOANSPREAD (EQUITYSPREAD) is the relative loan (equity) spread. EQUITYRETURN is the equity return. EQUITYINDEXRETURN is the equity index return. LOANRETURN is the loan return. LOANINDEXRETURN is the loan index return. PROBDEFAULT is the implied probability of default. DIFPROBDEFAULT is the change in implied probability of default. LAGDIFPROBDEFAULT is the lagged change in implied probability of default. SECURED is the collateralization dummy. ln(FACILITYSIZE) is the logarithmic value of the loan facility size. ln(NUMBSYN) is the logarithmic value of the number of syndicate members at initiation. LEVERAGE is the ratio of total debt to total assets. EPS is the earnings per share. TANGIBLE is the ratio of gross property, plant and equipment to total assets. ln(MARKETVALUE) is the logarithmic value of the market value. The standard errors are shown in the parenthesis.

	LOANSPREAD			EQUITYSPREAD		
	Full sample	Small firm	Large firm	Full sample	Small firm	Large firm
Panel A: OLS estimation of the loan and equity spread equation						
DUALMM	0.339**	0.862**	0.054	0.052	−0.481**	0.044
	(0.153)	(0.411)	(0.047)	(0.095)	(0.193)	(0.032)
LOANRETURN	−13.962***	−17.460***	0.306	−3.949***	−3.210*	0.232
	(3.580)	(4.137)	(3.467)	(1.446)	(1.650)	(0.540)
EQUITYRETURN	0.266**	0.225*	0.502***	−0.529**	−0.504	0.013
	(0.116)	(0.134)	(0.138)	(0.250)	(0.329)	(0.048)
RATEAISD	−0.001**	−0.001**	−0.001**	−0.001	−0.001	0.000
	(0.000)	(0.001)	(0.000)	(0.001)	(0.002)	(0.000)
SECURED	−0.338***	−0.294	−0.113	−0.517*	−0.668	−0.142**
	(0.117)	(0.202)	(0.090)	(0.305)	(0.524)	(0.057)
ln(FACILITYSIZE)	0.090	0.084	0.003	0.066	−0.269	0.004
	(0.066)	(0.109)	(0.033)	(0.078)	(0.169)	(0.020)
ln(NUMBSYN)	0.047	0.063	0.062**	−0.081	0.141	−0.025
	(0.046)	(0.079)	(0.031)	(0.060)	(0.092)	(0.016)
EQUITYINDEXRETURN	0.097	0.177	−0.203	0.537	0.164	0.120
	(0.176)	(0.321)	(0.184)	(0.452)	(0.792)	(0.195)
LOANINDEXRETURN	−7.007**	−10.215**	−0.796	−23.238***	−31.368***	−13.828***
	(2.959)	(4.761)	(2.161)	(4.214)	(7.897)	(1.576)
PROBDEFAULT	4.381***	3.259***	5.382***	6.036***	4.588**	0.595***
	(0.870)	(0.894)	(0.900)	(1.789)	(2.056)	(0.156)
DIFPROBDEFAULT	1.397	0.280	5.550**	1.494	0.595	0.841*
	(1.522)	(1.612)	(2.660)	(2.440)	(2.922)	(0.453)
LAGDIFPROBDEFAULT	3.145**	2.252	6.270***	−0.326	−2.699	2.382***
	(1.295)	(1.480)	(2.070)	(2.529)	(2.822)	(0.541)
EQUITYVOLATILITY	2.239***	2.284**	1.332**	1.722	1.721	1.138***
	(0.684)	(0.974)	(0.573)	(1.268)	(1.994)	(0.231)
LEVERAGE	−0.421	−0.728	−0.305*	0.870**	0.478	0.168
	(0.401)	(0.538)	(0.176)	(0.365)	(0.556)	(0.111)
EPS	0.001	0.016	0.000	−0.001	−0.056*	−0.000
	(0.002)	(0.024)	(0.001)	(0.002)	(0.030)	(0.000)
ln(MARKETVALUE)	−0.312***	−0.542***	−0.030	−0.692***	−1.408***	−0.068***
	(0.061)	(0.108)	(0.037)	(0.112)	(0.163)	(0.019)
TANGIBLE	0.054	−0.003	0.145	1.050***	1.665***	0.040
	(0.132)	(0.214)	(0.089)	(0.291)	(0.516)	(0.049)
INDUSTRY	YES	YES	YES	YES	YES	YES
CONSTANT	YES	YES	YES	YES	YES	YES
Adj. R^2	0.371	0.398	0.373	0.419	0.469	0.120
N	17664	8792	8872	17664	8792	8872
	SPREAD = LOANSPREAD			SPREAD = EQUITYSPREAD		
	Full sample	Small firm	Large firm	Full sample	Small firm	Large firm
Panel B: Probit estimation of the dual market maker equation						
SPREAD	0.173***	0.215***	0.119	0.006	−0.061	0.065
	(0.036)	(0.046)	(0.150)	(0.026)	(0.044)	(0.081)
LOANRETURN	0.034***	0.065***	0.019***	0.036***	0.068***	0.019***

(*continued on next page*)

Table 3 (*continued*)

	SPREAD = LOANSPREAD			SPREAD = EQUITYSPREAD		
	Full sample	Small firm	Large firm	Full sample	Small firm	Large firm
	(0.005)	(0.010)	(0.007)	(0.005)	(0.010)	(0.007)
EQUITYRETURN	3.611**	−4.864*	6.180***	3.797**	−4.796*	6.206***
	(1.539)	(2.654)	(1.876)	(1.505)	(2.497)	(1.878)
RATEAISD	0.003**	0.002	0.003	0.002**	0.001	0.003
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
SECURED	0.350	−0.272	0.337	0.335	−0.206	0.336
	(0.252)	(0.295)	(0.387)	(0.248)	(0.275)	(0.390)
ln(FACILITYSIZE)	0.043	−0.136	0.094	0.036	−0.134	0.089
	(0.127)	(0.154)	(0.161)	(0.126)	(0.156)	(0.160)
ln(NUMBSYN)	0.029	0.008	0.131	0.024	0.023	0.141
	(0.086)	(0.122)	(0.141)	(0.087)	(0.118)	(0.140)
EQUITYINDEXRETURN	−17.455***	−31.744***	−15.321***	−18.277***	−34.067***	−14.746***
	(4.419)	(7.953)	(5.912)	(4.294)	(7.294)	(5.414)
LOANINDEXRETURN	−3.521***	−4.243***	−3.178***	−3.428***	−3.998***	−3.164***
	(0.298)	(0.478)	(0.392)	(0.287)	(0.466)	(0.394)
PROBDEFAULT	0.061	−0.905	−0.866	0.776	−0.228	−0.242
	(0.970)	(1.039)	(2.233)	(1.007)	(1.075)	(1.918)
DIFPROBDEFAULT	0.528	1.052	6.738**	0.736	1.775	6.694**
	(1.540)	(1.733)	(3.390)	(1.654)	(1.920)	(3.334)
LAGDIFPROBDEFAULT	2.113	1.758	9.185**	3.001**	2.885	9.265**
	(1.545)	(1.837)	(4.286)	(1.510)	(1.875)	(4.158)
EQUITYVOLATILITY	5.340***	8.211***	3.764**	5.644***	8.512***	3.808**
	(1.164)	(1.714)	(1.753)	(1.154)	(1.695)	(1.736)
LEVERAGE	−0.359	−0.370	−0.696	−0.414	−0.372	−0.779
	(0.351)	(0.547)	(0.885)	(0.349)	(0.498)	(0.881)
EPS	0.021	0.152***	−0.104**	0.015	0.145***	−0.107**
	(0.020)	(0.054)	(0.044)	(0.020)	(0.050)	(0.044)
ln(MARKETVALUE)	0.490***	0.151	0.457**	0.441***	−0.033	0.454**
	(0.099)	(0.120)	(0.189)	(0.099)	(0.134)	(0.188)
TANGIBLE	−0.032	0.913***	−0.701	−0.072	0.777**	−0.691
	(0.284)	(0.344)	(0.449)	(0.284)	(0.324)	(0.453)
INDUSTRY	YES	YES	YES	YES	YES	YES
CONSTANT	YES	YES	YES	YES	YES	YES
Adj. R^2	0.270	0.444	0.223	0.258	0.415	0.222
N	15161	6923	7951	15161	6923	7951

* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

advantage could make it more profitable for the lead arranger to make equity markets. Thus, the wide loan spread could increase the incidence of dual market makers attracted by profit opportunities, rather than result from the presence of super informed market makers that reduce loan market liquidity. The OLS results do not determine whether the causality is from dual market maker to spreads, or the reverse. Since the two effects both lead to positive relation between LOANSPREAD and DUALMM, they enhance each other if both are present. As a result, the total effect measured in the OLS estimates can be inflated relative to the true effect of DUALMM on LOANSPREAD. Similar arguments can be applied when interpreting the single regression results of dual market maker presence shown in Table 3 Panel B: the positive and significant coefficient on loan liquidity does not address the question of causality.

Subsample analysis presented in Panel A of Table 3 indicates that the presence of a dual market maker is statistically significantly related to a reduction of equity spreads for the small firm subsample, but not for the full sample or the large firm subsample. The insignificant OLS results presented in Table 3 can be misleading since the explanatory variable, DUALMM, is endogenous. One possibility is that while the participation of dual market makers improves the liquidity and reduces the spread in the equity market, the decision of lead arrangers to participate in the equity market increases with the

spreads, and therefore profit opportunities, in the equity market. These two opposing effects can weaken each other, resulting in insignificant net effects that understate the true relationship between EQUITYSPREAD and DUALMM. In this case, the OLS estimates of the net effect could understate the true effect of DUALMM on EQUITYSPREAD.

We formally test for endogeneity in our OLS estimation of the DUALMM variable on spreads using the Durbin–Wu–Hausman (DWH) test (see Davidson and MacKinnon, 1993; Durbin, 1954; Hausman, 1978; Wu, 1973). The null hypothesis of this test is that, if the endogenous regressor's effects on the estimates are not meaningful, an OLS estimator should yield results consistent with a two-stage least squares estimator. A rejection of the null indicates an endogeneity problem and suggests that instrumental variables techniques are required.

To implement the test, we first regress DUALMM on all exogenous variables and obtain the regression residual (denoted RESIDUAL DUALMM). We then perform an augmented regression of loan or equity spreads on the explanatory variables including DUALMM, as well as RESIDUAL DUALMM. We perform this augmented regression twice, once with loan spreads as the dependent variable and then with equity spreads as the dependent variable. We perform an *F*-test on the null hypothesis that the coefficient associated with the RESIDUAL DUALMM variable is zero. The results of the *F*-test for both loan and equity spreads are shown in Table 4. The *F*-tests reject the null hypothesis of no endogeneity for the full sample, as well as for both firm size subsamples, indicating that the OLS analysis of spreads shown in Table 3 is not consistent and affirming the need to control for the endogenous DUALMM decision.

3.2. Simultaneous equation system methodology

To formally account for the endogeneity between the liquidity of the equity and loan markets, and the decision of dual market makers to participate in both equity and loan markets, we utilize a two-stage probit least squares estimation method corresponding to Maddala (1983) that permits simultaneous multivariate estimation when one of the endogenous variables is continuous and the other endogenous variable is discrete. The structural equation system we estimate is:

$$\text{SPREAD}_t = \gamma_1 \text{DUALMM}_t + \beta_1' \text{X}_1 + e_1 \quad (1)$$

Table 4
Durbin–Wu–Hausman test for endogeneity. The table reports the *F*-test result of an augmented regression of loan and equity spreads on RESIDUAL DUALMM, in addition to the other exogenous explanatory variables. The null hypothesis of the *F*-test is that the RESIDUAL DUALMM variable is insignificant. The large and small firm subsamples are based on the median value of the market capitalization of the borrowers as defined in Section 2.2. RESIDUAL DUALMM is the residual from a first stage regression of DUALMM on all exogenous variables (EQUITYRETURN, LOANRETURN, LOANINDEXRETURN, EQUITYINDEXRETURN, LEADSHAREOFMARKET, INCOMETOA, RATEAISD, SECURED, ln(FACILITYSIZE), ln(NUMBSYN), EQUITYINDEXRETURN, LOANINDEXRETURN, PROBDEFAULT, DIFPROBDEFAULT, LAGDIFPROBDEFAULT, EQUITYVOLATILITY, LEVERAGE, EPS, ln(MARKETVALUE), TANGIBLE, INDUSTRY). DUALMM is the dual market maker dummy. LOANSPREAD is the relative loan spread. LOANRETURN is the loan return. LOANINDEXRETURN is the loan index return. LOANNBA is the sum of loan bid and ask quotations. LEADSHAREOFMARKET is the lead arranger's share of the syndicated loan market. EQUITYSPREAD is the relative equity spread. EQUITYRETURN is the equity return. EQUITYINDEXRETURN is the equity index return. EQUITYVOLATILITY is the monthly equity volatility. PROBDEFAULT is the implied probability of default. DIFPROBDEFAULT is the change in implied probability of default. LAGDIFPROBDEFAULT is the lagged change in implied probability of default. SECURED is the collateralization dummy. RATEAISD is the basis point loan spread at initiation. ln(FACILITYSIZE) is the logarithmic value of the loan facility size. ln(NUMBSYN) is the logarithmic value of the number of syndicate members at initiation. LEVERAGE is the ratio of total debt to total assets. INCOMETOA is the ratio of operating income before depreciation to total assets. EPS is the earnings per share. TANGIBLE is the ratio of gross property, plant and equipment to total assets. ln(MARKETVALUE) is the logarithmic value of the market value.

	LOANSPREAD		EQUITYSPREAD	
	F-test: residual DUALMM = 0	*P*-value	*F*-test: residual DUALMM = 0	*P*-value
Full sample	33.47	(0.000)	21.71	(0.000)
Small firm subsample	23.69	(0.000)	6.02	(0.014)
Large firm subsample	3.02	(0.082)	6.53	(0.011)

The standard errors are shown in the parenthesis and the significance levels are indicated by ∗, ∗∗ and ∗∗∗ that represent 10%, 5% and 1% level, respectively.

and

$$\text{DUALMM}_t = \gamma_2 \text{SPREAD}_t + \beta_2' X_2 + e_2, \quad (2)$$

where SPREAD is either LOANSPREAD or EQUITYSPREAD, and X_1 and X_2 are vectors of other independent variables, including the instruments and the control variables. The two-stage procedure first estimates a reduced form model and expresses the endogenous SPREAD and DUALMM variables as a function of the exogenous variables. In the second stage, the predicted values of the SPREAD and DUALMM variables are then replaced on the right hand side of Eqs. (1) and (2). The Appendix contains a description of the econometrics of the two-stage procedure, as well as a list of variables contained in X_1 and X_2.

3.2.1. The economics behind the instrumental variables

3.2.1.1. Loan market instruments. The instrumental variables used to identify loan or equity spreads must vary with the spreads due to exogenous factors not directly related to the presence of a dual market maker. The instruments we use to identify loan market liquidity are EQUITYRETURN and LOANRETURN. For example, Chordia et al. (2002) show that down (up) markets are followed by low (high) liquidity and higher (lower) spreads. Chordia et al. (2005) find that liquidity is lower in down markets for both stock and bond markets. Brunnermeier and Pedersen (2009) explain theoretically that market-making firms' capital constraints are more likely to be hit in down markets and this can lead to liquidity deterioration when markets decline. Since equity market returns and loan market returns per se are unlikely to have a direct impact on the likelihood of being a dual market maker, we utilize them as instrumental variables for both loan and equity market equations.

Similarly, we select the instruments used to identify the lead arranger's decision to become an equity market maker as variables that are related to the information characteristics of the syndicated bank loan market, but not directly related to loan spreads. As a measure of the reputation and presence in the syndicated bank loan market of the lead arranger, we utilize the variable LEADSHAREOFMARKET, which is the lead arranger's share of the syndicated loan market. This variable directly measures the ability of the lead arranger to extract informational rents from its role as dual market maker as a function of its long term presence in the loan market. Since LEADSHAREOFMARKET reflects the market power of the lead arranger, we expect that the higher the LEADSHAREOFMARKET, the more likely the lead arranger is also an equity market maker so that information collected from the equity market is more beneficial for its loan market activities. The variable is obtained from LPC historical league tables and is rather stable over time. Therefore, it is unlikely to be directly related to loan spreads that fluctuate over time. Econometric tests of the instrumental variables, discussed in Section 3.2.2, confirm this choice.

Our next instrumental variable, INCOMETOA, is related to the informational advantage of the lead arranger. INCOMETOA is a measure of the operating profitability of the borrowing firm. Firms with higher operating profitability tend to generate higher amounts of income for a given asset base, ceteris paribus. That is, these firms generate more of their income from real growth options, which have convex cash flows. These growth options are more valuable in equity markets than in debt markets since in good outcome states, debt holders receive fixed payments whereas equity holders share in the firm's upside gain potential. It is this indirect interaction between the real option value of growth firms together with the information opacity of these intangible firms (net of the direct impact of intangibles, which is controlled for separately) that provides lead arrangers with the opportunity to utilize their informational advantage by becoming dual market makers. Moreover, firms with more physical assets tend to engage in regular refinancing through bank loans and leases. In contrast, firms with substantial real option growth borrow more intermittently, and therefore, when loans are granted the marginal value of bank-produced private, fundamental firm information is quite high, further encouraging dual market making. Thus, INCOMETOA is expected to be positively related to the likelihood that the lead arranger will be an equity market maker, but not directly related to equity or loan spreads.

3.2.1.2. Equity market instruments. For the simultaneous equation involving EQUITYSPREAD and DUALMM, we use the same instruments, EQUITYRETURN and LOANRETURN, to identify equity market liquidity as those used to identify loan market liquidity. The instruments used to identify the likeli-

hood of being a dual market maker are INCOMETOA and RATEAISD. For reasons explained previously, we expect INCOMETOA to affect the DUALMM decisions, but not influence the equity market liquidity measures. The other instrument, RATEAISD, is a measure of the borrower's credit risk exposure and is expected to be positively related to the DUALMM variable.[11] The lead arranger generates private information about the borrower's creditworthiness, which can be reused when the lead arranger chooses to act as an equity market maker. This information is more useful, the greater the risk of insolvency and the higher the RATEAISD. However, the credit spread would not directly impact equity spreads, which are determined by the structure and the interaction of informed traders, noise traders and market makers in the equity market. The variable LEADSHAREOFMARKET is not used as an instrument for DUALMM in the simultaneous equation estimation of EQUITYSPREAD and DUALMM because it failed the instrument tests, although results are robust to its inclusion.

3.2.2. Econometric tests of instrumental variables

For an instrument to be valid, it must satisfy two conditions: (1) relevance (i.e., directly correlated with the endogenous independent variable), and (2) exogeneity with respect to the structural equation (i.e., uncorrelated with the dependent variable once the endogenous independent variable and other covariates have been controlled for). In this subsection, we perform formal statistical tests based on a two-stage least squares regression of liquidity variables on the instrumented DUALMM variable.[12]

As suggested by Gujarati (2003) and Davidson and MacKinnon (2004), a Sargan–Hansen test can be used to test whether the instruments are exogenous to the structural equations. For the two-stage least squares estimator, the test statistic is the Sargan's statistic. To implement this test, we first extract the residuals from the instrumental variable regression of the original models. These extracted residuals are then regressed on a set of variables including a constant, the instruments, and all the control variables in the regression. The uncentered R^2 associated with this estimation is then extracted, and the Sargan statistic is estimated as the number of observations multiplied by R^2, which follows a chi-square distribution. The null hypothesis is that the Sargan's statistic is not statistically different from zero. The intuition is that when the instrumental variables are orthogonal to the residuals, the regression R^2 will be low. Failure to reject the null suggests that the instruments are orthogonal to the residuals and, therefore, the overidentifying restrictions are valid. Our estimation of the Sargan's statistic in Table 5 fails to reject the null, suggesting that our instruments are exogenous to the structural equations.

Next, we check whether the excluded instruments are relevant (i.e., correlated with the endogenous regressor) using the underidentification test – the Anderson (1951) canonical correlations test (see Hall et al. (1996)). The null hypothesis is that the equation is underidentified. A rejection of the null suggests that the model is identified and the instruments are relevant. Table 5 shows that the Anderson canonical correlation LR statistics are all significantly different from zero (at the 1% confidence level or better), indicating that our instruments are relevant.

Following Puri and Rocholl (2008), we implement the tests suggested by Bound et al. (1995) and Staiger and Stock (1997). To do so, we implement an *F*-test of the joint significance of the excluded instruments in the first stage regression. Bound et al. (1995) and Staiger and Stock (1997) propose a rule of thumb that the instruments are weak if the *F*-statistic is less than 10. Our estimates of the Bound et al. (1995) *F*-statistic presented in Table 5 are well above 10, suggesting that our instruments are not weak.

Stock and Yogo (2005) improve the Bound et al. (1995) and Staiger and Stock (1997) rule of thumb by formally developing the *F*-statistic and the corresponding critical values that are determined by the instrumental variable estimator, the number of instruments and endogenous variables used and the amount of bias to be tolerated (see Andrews and Stock (2006)). The Stock and Yogo (2005) statistic

[11] We could not use RATEAISD as an instrument for loan spreads because of the direct relationship between creditworthiness and loan spreads.

[12] As argued by Angrist and Kruger (2001), the two state least squares regression method is robust and generates consistent estimates even with a dummy endogenous variable. See also Angrist and Imbens (1995), Card (1995), Heckman and Vytlacil (1998). We are not aware of any similar statistics for testing instruments that explicitly account for a dummy endogenous variable.

Table 5
Tests for the instruments. The statistical tests are performed using a two-stage least squares regression of liquidity variables (EQUITYSPREAD and LOANSPREAD) on the instrumented DUALMM variables. The Sargan test checks for the validity of instruments. The Anderson underidentifcation test, the Bound et al. (1995) *F*-statistic, and the Cragg–Donald statistic investigate whether our system of equations are underidentified and whether our instruments are weak in model identification. The test statistic and the *P*-values are reported for the Sargan statistic and the Anderson underidentification tests. For the Cragg–Donald statistic, we report critical values based on TSLS size at the 5% significance level of a Wald test for the desired maximal size of 10, as presented in Stock and Yogo (2005).

	LOANSPREAD	EQUITYSPREAD
Sargan statistic	1.720	1.561
P-value	0.1897	0.2115
Anderson canonical correlation LR statistic	1858.792	541.362
Chi-sq(2) *P*-value	0.00	0.00
Bound et al. (1995) *F*-statistic	1054.946	278.837
"Rule of thumb" critical value	10	10
Cragg–Donald Wald *F*-statistic	1054.946	278.837
Stock Yogo critical values, maximal size of 10, of a 5% Wald test	19.93	19.93

is the *F*-statistic form of the Cragg and Donald (1993) statistic. If this statistic is above the corresponding critical values, then the null hypothesis of the presence of a weak instruments problem is rejected. Table 5 shows that the Cragg–Donald *F*-statistics are well above the Stock and Yogo (2005) critical value, strongly rejecting the weak instruments hypothesis. Overall, the results in Table 5 suggest that our instruments are exogenous to the structural equation and are strongly relevant to the underlying variable. Thus, we conclude that our instruments are valid, and the system is well-identified.

3.3. Simultaneous equation system results

3.3.1. Loan market liquidity effects

The first three columns of Table 6, Panel A present the effect of a dual market maker on loan market liquidity as estimated from Eq. (1). The full sample results show that the joint participation of lead arrangers in both the loan and the equity market significantly increases the loan spread (LOANSPREAD). The statistically significant (at the 1% level) coefficient on DUALMM takes a value of 0.253, suggesting that having a dual market maker in both the equity and loan market increases the loan spreads by 25.3 basis points. This effect is economically significant compared to the average loan spread of 121 basis points (see Table 2, Panel A), representing an increase of 21%. This finding is consistent with a negative liquidity effect, suggesting that by participating in the equity market the lead arranger learns valuable information from equity market order flows that gives it monopoly power in the loan market, which in turn increases the overall loan spread. To see how our results can be affected by borrower size, we separated our sample into two subsamples, large and small, based on the median value of the market capitalization of the borrowers. The results show that the effect of dual market makers' presence is statistically significant (at the 1% level) for the small firm subsample only. Consistent with our hypothesis, these results suggest that dual market makers play a bigger role in the liquidity of loan markets of smaller companies that are relatively opaque.

Several other variables also contribute to loan market liquidity. The full sample results show that loan spreads decrease significantly with increases in the loan prices (LOANRETURN), and increase when the default probability (PROBDEFAULT and LAGDIFPROBDEFAULT) is high. Loan spreads are lower for firms with more earnings per share (EPS), firms with more leverage (LEVERAGE), and secured loans (SECURED). The firm's equity return volatility (EQUITYVOLATILITY) is positively related to the loan spread. The loan market is more liquid (loan spreads are narrower) for a company with a more transparent information environment; i.e., loan spreads tend to be smaller for larger firms (ln(MARKETVALUE)). Loan spreads also increase with facility size (ln(FACILITYSIZE)) and the number of syndicate participants (ln(NUMBSYN)), indicating that our sample of larger deals may more likely include risky, leveraged loans with wider spreads. The adjusted R^2 values show that our specifications are able to explain 36.8% of the variation in the loan spreads. The control variable results are consistent across

Table 6
Joint multivariate estimation of loan and equity spreads and dual market maker decision. We utilize a two-stage probit least squares estimation method corresponding to Maddala (1983) to simultaneously estimate LOANSPREAD (EQUITYSPREAD) and DUALMM. Panel A presents the result of the SPREAD equation. Panel B presents the result of the DUALMM equation. DUALMM is the dual market maker dummy. The large and small firm subsamples are based on the median value of the market capitalization of the borrowers as defined in Section 2.2. LOANSPREAD (EQUITYSPREAD) is the relative loan spread. LOANRETURN is the loan return. LOANINDEXRETURN is the loan index return. LOANNBA is the sum of loan bid and ask quotations. LEADSHAREOFMARKET is the lead arranger's share of the syndicated loan market. EQUITYSPREAD is the relative equity spread. EQUITYRETURN is the equity return. EQUITYINDEXRETURN is the equity index return. EQUITYVOLATILITY is the monthly equity volatility. PROBDEFAULT is the implied probability of default. DIFPROBDEFAULT is the change in implied probability of default. LAGDIFPROBDEFAULT is the lagged change in implied probability of default. SECURED is the collateralization dummy. RATEAISD is the basis point loan spread at initiation. ln(FACILITYSIZE) is the logarithmic value of the loan facility size. ln(NUMBSYN) is the logarithmic value of the number of syndicate members at initiation. LEVERAGE is the ratio of total debt to total assets. INCOMETOA is the ratio of operating income before depreciation to total assets. EPS is the earnings per share. TANGIBLE is the ratio of gross property, plant and equipment to total assets. ln(MARKETVALUE) is the logarithmic value of the market value. The standard errors are shown in the parenthesis.

	LOANSPREAD			EQUITYSPREAD		
	Full sample	Small firm	Large firm	Full sample	Small firm	Large firm
Panel A: Estimation of the loan and equity spread equation						
DUALMM	0.253***	0.267***	0.020	−0.395***	−0.548***	−0.023
	(0.016)	(0.017)	(0.013)	(0.050)	(0.086)	(0.018)
LOANRETURN	−13.206***	−15.282***	−3.114***	−4.132***	−3.570*	0.083
	(0.935)	(1.262)	(0.948)	(1.480)	(2.112)	(0.865)
EQUITYRETURN	0.319***	0.332**	0.385***	−0.543***	−0.350	−0.010
	(0.097)	(0.151)	(0.067)	(0.151)	(0.241)	(0.064)
RATEAISD	−0.002***	−0.003***	−0.001***			
	0.000	(0.000)	(0.000)			
SECURED	−0.228***	0.081	−0.029	−0.358***	−0.694***	−0.088***
	(0.030)	(0.059)	(0.018)	(0.049)	(0.087)	(0.020)
ln(FACILITYSIZE)	0.099***	0.150***	0.002	0.120***	−0.196***	0.003
	(0.013)	(0.027)	(0.007)	(0.021)	(0.044)	(0.007)
ln(NUMBSYN)	0.018*	0.012	0.059***	−0.019	0.341***	−0.020***
	(0.010)	(0.018)	(0.007)	(0.018)	(0.039)	(0.007)
LOANINDEXRETURN	−1.941	−4.646	−0.001	−30.565***	−41.180***	−14.355***
	(2.832)	(5.192)	(1.612)	(4.610)	(8.596)	(1.588)
EQUITYINDEXRETURN	0.650**	0.511	−0.040	−0.721	−1.284	0.030
	(0.299)	(0.527)	(0.177)	(0.496)	(0.884)	(0.176)
PROBDEFAULT	4.113***	3.520***	4.785***	6.086***	3.656***	0.577***
	(0.128)	(0.177)	(0.140)	(0.193)	(0.274)	(0.119)
DIFPROBDEFAULT	−0.299	−0.836	2.977***	1.800	0.157	0.909
	(0.806)	(1.059)	(1.005)	(1.251)	(1.737)	(0.850)
LAGDIFPROBDEFAULT	2.152***	2.050*	3.544***	1.105	−2.220	2.757***
	(0.804)	(1.048)	(1.049)	(1.254)	(1.701)	(0.937)
EQUITYVOLATILITY	1.317***	0.717**	1.144***	3.262***	3.195***	1.460***
	(0.188)	(0.303)	(0.135)	(0.356)	(0.590)	(0.140)
LEVERAGE	−0.464***	−0.816***	−0.201***	1.066***	0.703***	0.228***
	(0.052)	(0.080)	(0.047)	(0.085)	(0.143)	(0.046)
EPS	−0.005*	0.001	0.000	0.004	−0.017	−0.001
	(0.003)	(0.007)	(0.001)	(0.005)	(0.013)	(0.001)
ln(MARKETVALUE)	−0.448***	−0.616***	−0.041***	−0.550***	−1.507***	−0.043***
	(0.012)	(0.023)	(0.011)	(0.024)	(0.035)	(0.011)
TANGIBLE	0.025	−0.025	0.095***	0.983***	1.526***	0.011
	(0.034)	(0.058)	(0.022)	(0.055)	(0.086)	(0.023)
INDUSTRY	YES	YES	YES	YES	YES	YES
CONSTANT	YES	YES	YES	YES	YES	YES
Adj. R^2	0.368	0.348	0.317	0.422	0.456	0.123
N	15,404	7357	8047	17,578	8792	8786

(*continued on next page*)

Table 6 (*continued*)

	SPREAD = LOANSPREAD			SPREAD = EQUITYSPREAD		
	Full sample	Small firm	Large firm	Full sample	Small firm	Large firm
Panel B: Estimation of the dual market maker equation						
SPREAD	0.007	−0.116	0.159	0.101	−0.380	−21.872
	(0.108)	(0.118)	(0.499)	(0.181)	(0.245)	(69.586)
LEADSHAREOFMARKET	0.039***	0.072***	0.022***			
	(0.001)	(0.003)	(0.002)			
INCOMETOA	4.420***	3.166***	4.380***	4.387***	4.360***	1.057
	(0.258)	(0.794)	(0.262)	(0.349)	(0.800)	(10.106)
RATEAISD	0.002***	0.003***	0.002***	0.001***	0.002***	0.005
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.013)
SECURED	0.334***	−0.137	0.410***	0.401***	−0.185	−2.145
	(0.046)	(0.088)	(0.055)	(0.095)	(0.183)	(8.638)
ln(FACILITYSIZE)	0.095***	0.051	0.132***	0.129***	0.003	0.185
	(0.023)	(0.046)	(0.023)	(0.021)	(0.068)	(0.299)
ln(NUMBSYN)	0.003	−0.016	0.042	0.168***	0.358***	−0.343
	(0.016)	(0.028)	(0.036)	(0.020)	(0.049)	(1.443)
LOANINDEXRETURN	−18.831***	−27.561***	−16.177***	−13.583**	−33.873***	−319.784
	(4.132)	(7.571)	(5.076)	(5.955)	(9.916)	(982.078)
EQUITYINDEXRETURN	−3.487***	−3.690***	−3.269***	−3.008***	−2.618***	−1.051
	(0.407)	(0.728)	(0.529)	(0.373)	(0.631)	(7.162)
PROBDEFAULT	0.425	−0.471	−1.742	−0.299	1.218	10.087
	(0.494)	(0.479)	(2.402)	(1.086)	(0.959)	(39.216)
DIFPROBDEFAULT	1.925	0.341	12.311***	0.831	−0.551	30.423
	(1.179)	(1.413)	(3.212)	(1.139)	(1.309)	(66.095)
LAGDIFPROBDEFAULT	4.269***	2.252	15.840***	3.671***	−0.312	71.192
	(1.299)	(1.473)	(3.823)	(0.999)	(1.323)	(181.441)
EQUITYVOLATILITY	5.206***	9.074***	4.147***	5.048***	5.236***	33.059
	(0.387)	(0.590)	(0.720)	(0.316)	(0.356)	(90.437)
LEVERAGE	−0.336***	−0.439**	−0.584***	0.152	0.631***	4.500
	(0.101)	(0.181)	(0.188)	(0.189)	(0.151)	(14.170)
EPS	0.016***	0.086***	−0.025***	−0.009*	−0.001	−0.042
	(0.004)	(0.012)	(0.007)	(0.005)	(0.012)	(0.032)
ln(MARKETVALUE)	0.415***	0.025	0.425***	0.422***	−0.484	−0.771
	(0.041)	(0.074)	(0.034)	(0.127)	(0.387)	(3.515)
TANGIBLE	−0.289***	0.361***	−0.821***	−0.706***	0.594	−0.173
	(0.051)	(0.089)	(0.082)	(0.222)	(0.374)	(3.095)
INDUSTRY	YES	YES	YES	YES	YES	YES
CONSTANT	YES	YES	YES	YES	YES	YES
Chi^2	4721.541	2761.284	2166.048	3273.334	956.441	1981.341
N	15,404	7357	8047	17,578	8792	8786

* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

each size subsample, with the exception of the facility size variable (significantly positive for the small firm subsample only) and the number of syndicate members (significantly positive for the large firm subsample only). These subsample results reinforce the information producing role of dual market makers for small borrowing firms. Loan spreads tend to be larger, the larger the facility size for these informationally opaque firms because of the loan's increased risk. Further, as shown in Panel B of Table 2, syndicates for the small firm subsample are significantly smaller then for the large firm subsample, so as to incentivize the lead arranger (holding a larger stake in the loan) to actively monitor the small firm borrower. Thus, there are limits to the potential size of the syndicate for small firms since larger syndicates may be associated with increasingly risky loans that have lower returns, thereby reducing the statistical significance of the NUMBSYN coefficient for the small firm subsample.

The first three columns of Panel B of Table 6 describe the determinants of the dual market maker decision from the loan market perspective. The probability of the existence of a dual market maker is higher the more profitable the equity trading opportunities using the lead arranger's information

advantage; i.e., the higher the stock return volatility (EQUITYVOLATILITY) and the larger the equity size (ln(MARKETVALUE)). The riskier the stock, the more information advantage the dual market makers potentially have relative to other market makers. The larger the equity market size, the more trading volume they can generate using their information advantage. Lead arrangers are more likely to trade in the equity market if they can profitably use the information they extract from the equity market to trade in the loan market, as when they have more market power in the loan market, captured by the LEADSHAREOFMARKET variable. Moreover, the likelihood of a dual market maker increases the riskier the loan, as indicated by the positive coefficients on the loan coupon rate (credit spread at initiation, denoted RATEAISD), lagged change in default probability (LAGDIFPROBDEFAULT), and the secured dummy variable (SECURED). This is consistent with the dual market maker's greater information advantage for riskier assets. These results are consistent across the firm size subsamples, with the exception that the coefficients on the SECURED, FACILITYSIZE and MARKETVALUE variables are positive and statistically significant for the large firm subsample only. This indicates that a relationship bank's private information (rather than observable variables such as collateral or size alone) impacts the lead arranger's decision to simultaneously trade in the equity market.

It is also worth noting that the coefficient on DUALMM estimated for the full sample using the simultaneous equation system in Panel A of Table 6 is smaller in terms of magnitude (with a value of 0.253) as compared to the coefficient estimate using simple OLS in column 1 of Table 3, Panel A (with a value of 0.339), although both are statistically significant. These magnitude differentials are consistent with our conjecture that the positive relation between LOANSPREAD and DUALMM may be driven by two effects – that the lead arrangers are more likely to trade in the equity market when the loan spreads are large and the presence of dual market maker increases the loan spreads (see Section 3.1). The simultaneous equation framework allows us to separate the two effects, whereas the OLS result captures the joint effect and thus produces inflated coefficient estimates.

3.3.2. Equity market liquidity effects

The last three columns of Panel A of Table 6 present the simultaneous equation results for equity market liquidity. In contrast to the loan market liquidity case, the presence of a dual market maker significantly decreases the equity spread (EQUITYSPREAD). After controlling for firm-specific and industry effects, using the full sample, the DUALMM variable has a statistically significant (at the 1% level) coefficient of −0.395. That is, the presence of an equity market maker that is also the lead arranger of a bank loan syndicate decreases the equity spread by 39.5 basis points. Given that the average equity spread is approximately 111 basis points (see Table 2), the effect of the dual market maker on spread reduction is economically important at 35%. This result is consistent with the liquidity enhancement effect, in that the loan syndicate lead arranger with an information advantage is a natural liquidity provider in the more transparent and competitive equity market and, therefore, the presence of a dual market maker decreases overall equity spreads. Firm size subsample results (in the last two columns of Panel A, Table 6) show that the liquidity enhancement effect of dual market makers is only significant for the small firm subsample. Consistent with our hypothesis, these results suggest that dual market makers play a bigger role providing liquidity to the equity markets of smaller, more informationally opaque companies.

In addition, the full sample results show that the equity spread narrows when the equity and loan return (EQUITYRETURN and LOANRETURN) is positive or when the loan is secured (SECURED) and widens when the default probability (PROBDEFAULT) is high. The spread also correlates positively with equity volatility (EQUITYVOLATILITY), consistent with the idea that risk averse market makers set a higher spreads for riskier stocks (see, for example, Ho and Stoll, 1981). Equity spreads are also wider the greater the firm's leverage (as shown by the positive coefficient on the LEVERAGE variable), due to the greater market maker inventory holding costs associated with risky, relatively high cost stocks. The equity of firms with larger market capitalization (ln(MARKETVALUE)) tends to be more liquid, but the spread increases with the loan facility size (ln(FACILITYSIZE)), suggesting that our sample of larger loan syndications may include risky, leveraged loans. The adjusted R^2 values show that our specifications are able to explain 42.2% of the variation in the equity spreads.

Examining the control variables for the equity spread regressions divided into firm size subsamples (presented in the last two columns of Panel A, Table 6) provides further support consistent with our

hypothesis that the private information produced by dual market makers impacts the liquidity of equity issued by small, informationally opaque firms. Although most control variable results are the same as in the full sample, the coefficient on TANGIBLE (FACILITYSIZE) is statistically significant and positive (negative) for the small firm subsample only, suggesting that the larger firms with tangible assets within the small firm subsample benefit from the presence of a dual market maker through lower equity spreads. Moreover, the coefficient on the NUMBSYN variable is statistically significant and positive (negative) for the small (large) firm subsample, suggesting that small, tightly controlled syndicates are required for small, but not large firms in order to obtain lower equity spreads in the presence of a dual market maker.

The last three columns of Table 6, Panel B describes the determinants of the decision to be a dual market maker, as estimated in the simultaneous equation system of EQUITYSPREAD and DUALMM. Using the full sample, the likelihood of having a dual market maker is higher if trading in stocks based on the lead arranger's information advantage is more profitable; that is, when the stock return volatility (EQUITYVOLATILITY) is high and when the equity market is large (ln(MARKETVALUE)). The lead arrangers are more likely to trade in the equity market when there is greater uncertainty about the value of the company, which gives the lead arrangers a greater information advantage relative to other equity market makers. Thus, as the loan becomes riskier (RATEAISD), the likelihood of a dual market maker increases. These results are consistent with those shown in the first column of Table 6, Panel B for the loan market, although the coefficients on the control variables are significant for the small firm subsample only.

Consistent with the economics behind the instrumental variables, the estimated coefficient on DUALMM is statistically significant (at the 1% level) when estimated using the simultaneous equation system as compared to insignificant under OLS estimation in Table 3. If, as our endogeneity analysis suggests, EQUITYSPRD and DUALMM are determined by two opposing forces, the OLS analysis cannot disentangle the two effects and the net effect using OLS is statistically insignificant. In contrast, the simultaneous system of equations can disentangle the two opposite effects: (1) lead arrangers are more likely to trade in the equity market when the equity spreads are large, and (2) the presence of dual market maker reduces the equity spreads according to the liquidity enhancement effect. Thus, our econometric results are consistent with the economics behind the model specification.

4. Robustness checks

4.1. Controlling for price fluctuations

In Section 3, we follow established practice and measure liquidity using the relative spread, defined as the dollar spread divided by securities prices. Since asset prices vary considerably in the cross-section, the standardization produces economically sensible liquidity measures that reflects percentage trading cost and can be compared cross-sectionally. However, as a robustness check, we examine whether our results could be driven by fluctuations in securities prices over time, rather than by the liquidity effects measured by dollar spreads. To address this concern, we control for prices by adding the inverse of price as an additional control variable in the simultaneous equation system modeled in Section 3.3. Column 1 in Table 7, Panels A and B show that controlling for the inverse of price does not change our major result that the loan spreads increase and equity spreads decrease in the presence of a dual market maker.

4.2. Alternative definition of dual market maker

In a related robustness check, we expand the definition of a dual market maker to include specialist firms on the NYSE, so that if the specialist in the borrowing firm's stock is owned by a lead arranger, we designate the deal as having a dual market maker. To identify specialist dual market makers, we start from a list of specialists in the NYSE specialist directories and manually matched the specialists to the parent banks. Column 2 in Panels A and B of Table 7 show that our major results are robust to broadening our definition of dual market maker to include NYSE specialists. Indeed, the greater impact

Table 7
Simultaneous equation system estimation, robustness checks. We consider various robustness checks on the effect of DUALMM on loan and equity spreads. Panel A presents the results for LOANSPREAD. Panel B presents the results for EQUITYSPREAD. DUALMM is the dual market maker dummy. LOANSPREAD is the relative loan spread. LOANRETURN is the loan return. LOANINDEXRETURN is the loan index return. LEADSHAREOFMARKET is the lead arranger's share of the syndicated loan market. EQUITYSPREAD is the relative equity spread. EQUITYRETURN is the equity return. EQUITYINDEXRETURN is the equity index return. EQUITYVOLATILITY is the monthly equity volatility. PROBDEFAULT is the implied probability of default. DIFPROBDEFAULT is the change in implied probability of default. LAGDIFPROBDEFAULT is the lagged change in implied probability of default. SECURED is the collateralization dummy. RATEAISD is the basis point loan spread at initiation. ln(FACILITYSIZE) is the logarithmic value of the loan facility size. ln(NUMBSYN) is the logarithmic value of the number of syndicate members at initiation. LEVERAGE is the ratio of total debt to total assets. INCOMETOA is the ratio of operating income before depreciation to total assets. EPS is the earnings per share. TANGIBLE is the ratio of gross property, plant and equipment to total assets. ln(MARKETVALUE) is the logarithmic value of the market value. 1/LOANPRICE (1/STOCKPRICE) is the inverse of the price of the loan (stock). LAG_VOLUME is the lagged equity turnover ratio. Column 1 controls for the price level. Column 2 considers an alternative definition of DUALMM that also includes NYSE specialists. Columns 3a and 3b considers subsample analysis by bank size. Column labeled "large" refers to the subsample where the lenders are the top 5 in terms of market capitalization. Column labeled "small" refers to the rest of the sample. Column 4 employs a matched sample. Column 5 estimates fixed bank effects. Column 6 controls for lagged equity trading volume. Columns 1–4 and 6 utilize the two-stage procedure by Maddala (1983). Column 5 is estimated using a two-stage least squares estimation method. The standard errors are shown in the parenthesis.

	(1)	(2)	(3a) Small bank	(3b) Large bank	(4)	(5)
Panel A: Loan spread						
DUALMM	0.165***	0.302***	0.161***	0.642***	0.393***	0.989**
	(0.013)	(0.020)	(0.013)	(0.077)	(0.030)	(0.409)
LOANRETURN	−6.794***	−13.113***	−8.855***	−27.656***	−12.402***	−12.013***
	(0.660)	(0.942)	(1.094)	(2.244)	(1.412)	(0.887)
EQUITYRETURN	0.141**	0.324***	0.273**	0.364*	0.275*	0.426***
	(0.069)	(0.098)	(0.118)	(0.214)	(0.150)	(0.092)
RATEAISD	−0.000	−0.001***	−0.002***	−0.002***	−0.002***	−0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
SECURED	−0.162***	−0.341***	−0.279***	−0.189***	−0.040	−0.236***
	(0.021)	(0.033)	(0.041)	(0.057)	(0.047)	(0.052)
LFACILITYSIZE	−0.068***	0.060***	0.132***	−0.206***	−0.088***	0.047***
	(0.009)	(0.013)	(0.016)	(0.045)	(0.019)	(0.014)
LNUMBSYN	−0.002	0.014	0.038***	−0.049*	−0.044***	0.026
	(0.007)	(0.011)	(0.012)	(0.028)	(0.016)	(0.017)
LOANINDEXRETURN	−1.885	−1.193	−0.139	5.270	0.212	
	(2.014)	(2.878)	(3.357)	(6.972)	(4.117)	
EQUITYINDEXRETURN	0.370*	0.708**	0.621*	1.232*	0.442	0.664
	(0.213)	(0.305)	(0.362)	(0.695)	(0.443)	(0.445)
PD	1.849***	4.073***	4.159***	5.555***	3.094***	4.687***
	(0.095)	(0.130)	(0.151)	(0.388)	(0.211)	(0.156)
DPD	−0.660	−0.114	0.429	−6.073***	−0.030	
	(0.574)	(0.822)	(0.995)	(1.838)	(1.319)	
LAGDPD	−0.370	2.200***	4.094***	−7.395***	2.905**	1.088
	(0.572)	(0.818)	(0.973)	(1.933)	(1.148)	(0.786)
EQUITYVOLATILITY	−0.514***	0.910***	1.882***	0.250	2.048***	0.958
	(0.146)	(0.205)	(0.211)	(0.607)	(0.266)	(0.583)
LEVERAGE	0.419***	−0.225***	−0.534***	−1.017***	−0.431***	−0.269***
	(0.038)	(0.054)	(0.065)	(0.154)	(0.084)	(0.053)
EPS	0.002	−0.005*	−0.007**	−0.005	−0.006	−0.036***
	(0.002)	(0.003)	(0.003)	(0.012)	(0.005)	(0.003)
LMV	−0.159***	−0.451***	−0.422***	−0.542***	−0.441***	−0.298***
	(0.010)	(0.013)	(0.014)	(0.038)	(0.017)	(0.030)
TANGIBLE	−0.045**	−0.088**	−0.128***	0.177**	−0.074	−0.050
	(0.023)	(0.035)	(0.041)	(0.085)	(0.053)	(0.036)
1/LOANPRICE	8.303***					
	(0.075)					
Adj. R^2	0.694	0.368	0.389	0.360	0.349	
N	15161	15404	10466	4938	7567	15929
					Wald chi^2	24743
					Prob > chi^2	0.00

(*continued on next page*)

Table 7 (*continued*)

	(1)	(2)	(3a) Small bank	(3b) Large bank	(4)	(5)	(6)
Panel B: Equity spread							
DUALMM	−0.153***	−0.544***	−0.119***	−0.475***	−0.380**	−0.656*	−0.399***
	(0.029)	(0.090)	(0.038)	(0.117)	(0.166)	(0.337)	(0.050)
LOANRETURN	−2.695*	−4.157***	−3.683**	−5.621*	−1.164	−3.042**	−4.294***
	(1.493)	(1.523)	(1.467)	(3.016)	(1.418)	(1.285)	(1.482)
EQUITYRETURN	−0.334**	−0.565***	−0.751***	−0.174	−0.285*	−0.439***	−0.510***
	(0.155)	(0.157)	(0.158)	(0.288)	(0.150)	(0.126)	(0.152)
SECURED	−0.492***	−0.231***	−0.360***	−0.375***	−0.263***	−0.528***	−0.357***
	(0.045)	(0.071)	(0.054)	(0.090)	(0.046)	(0.063)	(0.050)
LFACILITYSIZE	0.047**	0.201***	−0.027	0.372***	0.086***	0.146***	0.124***
	(0.021)	(0.028)	(0.021)	(0.063)	(0.023)	(0.019)	(0.021)
LNUMBSYN	−0.090***	−0.001	−0.098***	0.014	−0.123***	−0.045*	−0.017
	(0.017)	(0.020)	(0.019)	(0.037)	(0.021)	(0.023)	(0.018)
LOANINDEXRETURN	−28.127***	−31.001***	−24.151***	−37.207***	−22.344***	−21.924***	−0.701
	(4.555)	(4.803)	(4.536)	(9.608)	(4.199)	(3.971)	(0.496)
EQUITYINDEXRETURN	−0.619	−0.977*	−0.024	−0.589	0.240		−29.675***
	(0.482)	(0.542)	(0.493)	(0.984)	(0.458)		(4.612)
PD	5.347***	6.076***	9.032***	1.193**	2.677***	6.330***	6.121***
	(0.246)	(0.200)	(0.209)	(0.475)	(0.196)	(0.181)	(0.194)
DPD	0.091	1.746	−1.864	7.319***	1.949	3.583***	2.181*
	(1.286)	(1.297)	(1.341)	(2.400)	(1.286)	(1.062)	(1.254)
LAGDPD	−2.999**	1.503	−4.655***	9.834***	6.283***		1.328
	(1.286)	(1.316)	(1.310)	(2.477)	(1.093)		(1.261)
EQUITYVOLATILITY	3.245***	3.957***	1.552***	6.567***	−0.269	2.676***	3.286***
	(0.337)	(0.500)	(0.342)	(0.753)	(0.262)	(0.484)	(0.358)
LEVERAGE	0.852***	0.819***	0.739***	1.205***	0.606***	0.889***	1.039***
	(0.084)	(0.087)	(0.088)	(0.233)	(0.087)	(0.068)	(0.085)
EPS	0.019***	0.007	0.010**	−0.026*	−0.030***	0.013***	0.004
	(0.003)	(0.005)	(0.004)	(0.015)	(0.006)	(0.003)	(0.005)
LMV	−0.422***	−0.503***	−0.394***	−0.822***	−0.503***	−0.618***	−0.545***
	(0.022)	(0.036)	(0.022)	(0.045)	(0.017)	(0.026)	(0.024)
TANGIBLE	0.568***	1.091***	0.666***	1.487***	0.194**	0.651***	0.969***
	(0.051)	(0.053)	(0.054)	(0.112)	(0.090)	(0.056)	(0.055)
1/STOCKPRICE	1.157***						
	(0.073)						
LAG_VOLUME							−10.109***
							(−1.851)
Adj. R^2	0.419	0.422	0.516	0.386	0.382		0.424
N	15161	17578	10903	6675	8342	18877	17560
					Wald chi^2	21029	
					Prob > chi^2	0.00	

* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

of the dual market maker effect on spreads is indicated by the fact that the specialist dual market makers are large banking firms (Goldman Sachs and Bank of America FleetBoston).

4.3. Controlling for bank size effects

In this section, we examine whether our results are driven by bank size or other spurious effects. In order to check whether bank size is driving our results, we separated our sample into two subsamples based on the size of the lead arranger using the definition shown in Table 2, where the top five banks (in terms of market capitalization) are designated as large. As shown in Panels A and B of Table 7, columns 3a and 3b, the presence of a dual market maker increases loan spreads significantly (at the 1% level) and decreases equity spreads significantly (at the 1% level) for both large and small bank subsamples. However, the size of the effect is substantially larger for the large bank subsample, as

indicated by the greater absolute size of the coefficients on the dual market maker variable for both loan and equity spreads. This result is consistent with the possibility that large banks have better information gathering and mobilization mechanisms than small banks, thereby leading to a larger dual market maker effect. However, the persistence of a statistically significant result for small banks shows that the impact of the dual market maker transcends bank size alone.

We also conducted a matched sample analysis where we estimate the simultaneous equation system using only the dual market maker observations and the matched sample of non-dual market maker observations, as described in detail in Section 4.6. This alternative sample allows us to control for a broader list of variables in addition to firm size and bank size. The matched sample results are show in Panels A and B, Table 7, column 4. The coefficient on DUALMM for loan (equity) market spreads is 0.393 (−0.38) and significant at the 1% (5%) level, consistent with our results presented in Table 6.

To further control for any bank-specific effects on the spreads we estimated the effect of the dual market maker on spreads using a two-stage least squares approach with bank fixed effects. In the first stage, the variable DUALMM is regressed on the instruments and the control variables defined in the appendix Eqs. (A.7) and (A.9). In the second stage, the loan (equity) spreads are regressed on the fitted DUALMM variable and other variables as defined in the appendix, Eqs. (A.6) and (A.8).[13] The results are reported in Table 7, Panels A and B, column 5. For the loan spread equation, the coefficient on DUALMM is 0.989 and significant at 5% level. For the equity spread equation, the coefficient on DUALMM is −0.656 and significant at the 10% level. These coefficients are qualitatively similar to the estimated obtained in the simultaneous equation model in Section 3.[14]

4.4. Controlling for lagged trading volume

We check the robustness of our results when including trading volume as an explanatory variable, where trading volume is calculated as the volume of equity trades divided by the number of shares outstanding. Since volume is highly correlated with spreads, we use lagged volume measure to avoid possible endogeneity issues. We incorporate the volume variable into our analysis of equity spreads only, since loan trading volume data are unavailable. Table 7, Panel B column 6 presents the results controlling for equity trading volume, with results very similar to those in Table 6.

4.5. Time series effects

In this paper, we focus on the cross-sectional impact of dual market makers on equity and loan market spreads. A full analysis of the time series effects of the dual market maker phenomenon issue is outside the scope of this paper, in part because the relationship banker may choose to initiate equity market making activities at any time during the weeks or months that the syndicated bank loan is being structured, rather than on the deal activation date. However, Table 8 provides some illustrative evidence, from a time series perspective, regarding the spreads around the loan origination date. Rather than using a dummy variable to capture before/after origination, we use a continuous variable, the days before/after loan origination, as the decision to become a dual market maker may not occur exactly at loan origination. The days before/after loan origination is computed as the difference between the origination date and the date of the spread observation. The tests are performed for 112 days (16 weeks) before and after the loan origination date, and for the subset of 57 days (8 weeks) through 112 days (16 weeks) before and after the loan origination date. The results presented in Table 8 show that controlling for calendar time, equity spreads for the non-dual market maker subsample increase over deal time, whereas they do not for the dual market maker subsample. This time-series analysis suggests that, relative to the non-dual market maker subsample, the presence of dual market

[13] We dropped LOANINDEXRETURN and LAGDIFPROBDEFAULT from Eq. (A.7) as these two variables are insignificant. Similarly, insignificant variables LOANINDEXRETURN and DIFPROBDEFAULT are dropped from Eq. (A.9) for the same reason.

[14] Note that the magnitude of the coefficients in the two-stage least squares estimation with fixed effects here is not directly comparable to those from the simultaneous equation systems in Section 3 since we could not incorporate fixed effects into a simultaneous equation system with a dichotomous variable.

Table 8
OLS regressions of spreads pre/post loan initiation. We perform OLS regression of EQUITYSPRD on the days before/after loan initiation and the calendar date. EQUITYSPRD is the relative equity spread. The days before/after variables is computed as the difference between the initiation date and the date of the spread observation. Hence, an observation 5 days before loan initiation will have a value of −5 while an observation 5 days following loan initiation will take a value of +5. The tests are performed for 112 days (16 weeks) before and after the loan origination date, and for the subset of 57 days (8 weeks) through 112 days (16 weeks) before and after the loan origination date. The Huber–White robust standard errors that allow for within firm correlation are shown in the parenthesis.

Subsample	Yes DUALMM 16 weeks before/after	No DUALMM 16 weeks before/after	Yes DUALMM 16 through 8 weeks before/after	No DUALMM 16 through 8 weeks before/after
Dependent variable	EQUITYSPRD	EQUITYSPRD	EQUITYSPRD	EQUITYSPRD
Days before/after	0.0000236	0.0000143**	0.0000268	0.0000141**
	(0.00001724)	(0.00000574)	(0.00001937)	(0.00000572)
Calendar Date	−0.0000075***	−0.0000024	−0.0000101**	−0.0000044***
	(0.00000262)	(0.00000220)	(0.00000374)	(0.00000153)
Intercept	0.1194319***	0.0447509	0.1585717**	0.0732817***
	(0.04046660)	(0.03200171)	(0.05767773)	(0.02327925)
R^2	0.02297	0.006195	0.02352	0.03855
N	2866	14,224	1443	6986

* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

maker did contribute to the reduction of equity spreads around loan initiation and therefore is consistent with the cross-sectional findings reported in the paper.[15]

4.6. Propensity score matching

As another robustness test of our empirical methodology, we use propensity score matching to test whether loan spreads and equity spreads differ across dual and non-dual market makers.[16] We utilize probit models in order to construct the propensity score. When testing loan spread differences, the regressors in the probit model are those presented in the first column of Panel B, Table 6, with the exception of the loan spread variable. We exclude the loan spread variable as it is one of our test variables. When testing equity spread differences, the regressors in the probit model are those presented in the second column of Panel B, Table 6, similarly excluding the equity spread variable. The probit estimation permits each observation to be given a score based on how likely there is to be a dual market maker present. Those dual market maker observations with propensity scores outside of the range of propensity scores associated with non-dual market maker observations are eliminated to ensure that propensity scores overlap.

Matches are then formed between dual market maker and non-dual market maker observations based on two criteria: (1) the propensity score and (2) the number of equity market makers. First, we consider the closeness of propensity scores, known as nearest neighbor matching method. We match each dual market maker observation to its single closest non-dual market maker observation,

[15] We also graphed the presence of dual market makers over the 32 week period surrounding the deal active date. There is no significant difference in the number of dual market makers over the 16 weeks before and after the loan origination date, although there is a slight increase when comparing the weeks −16 to −8 and +8 to +16, i.e., excluding the 16 weeks immediately surrounding the deal active date, consistent with the cumulative presence of dual market makers over time.

[16] See Rosenbaum and Rubin (1983, 1985a, 1985b) for a discussion of the propensity score matching methodology. The propensity score matching methodology has been used in the finance literature; see, for example Heckman et al. (1998), Drucker and Puri (2005), Gottesman and Roberts (2007), Michaely and Roberts (2007), Bharath et al. (2011), and Saunders and Steffen (2008).

Table 9
Matched tests. Propensity scores are used to identify matches between those observations associated with a dual market maker and those that are not. To ensure that propensity scores overlap, those dual market maker observations whose propensity scores are outside of the range of propensity scores associated with non-dual market maker observations are eliminated. Nearest neighbor matching is implemented using *k*-nearest neighbors, where *k* is defined as 1, 50, and 100 (NN(1), NN(50), and NN(100), respectively. Matching is without replacement for NN(1) and with replacement for NN(50) and NN (100). Exact cell matches are also reported, where both pairs of the match have exactly identical number of equity market makers. Values of loan spread and equity spread are reported for the dual market maker and non-dual market maker matched pairs, as well as the difference and standard error.

		Loan spread	Equity spread
NN(1)	Dual market maker	1.2749	0.8338
	Non-dual market maker	0.8949	0.9885
	Difference	0.3800***	−0.1547***
	Standard error	0.0301	0.0441
NN(50)	Dual market maker	1.2749	0.8338
	Non-dual market maker	0.9260	0.9214
	Difference	0.3489***	−0.0876***
	Standard error	0.0267	0.0196
NN(100)	Dual market maker	1.2749	0.8338
	Non-dual market maker	0.9135	0.8812
	Difference	0.3614***	−0.0474**
	Standard error	0.0268	0.0192

* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

designated NN(1). We also match each dual market maker observation to the *k*-nearest neighbors, where the dual market maker observation is matched to the average of the *k*-closest non-dual market maker observations. In addition to the $k = 1$ case (NN(1)), we specify *k* as 50 and 100, designated NN(50) and NN(100), respectively.[17]

To control for the number of equity market makers, we limit the candidates for matches to those with the same number of equity market makers. That is, we perform the NN(1), NN(50), and NN(100) matching techniques, but only consider non-dual market makers for a match with a given dual market maker observation if both share the exact same number of equity market makers. For example, if the dual market maker observation has three equity market makers, then matches are only considered from the subset of non-dual market maker observations that also have three equity market makers. Out of these candidates, the nearest neighbor propensity score methodology is employed to construct the dual and non-dual market maker subgroups.

Once the matches are identified, we estimate the significance of the difference between the values of loan and equity bid-ask spreads across the dual market marker and non-dual market maker subgroups. The results of the propensity score matching tests are presented in Table 9. Loan spreads for the subgroup with dual market makers are significantly (at the 1% level) higher (difference ranging from 0.35 to 0.38) than if there are no dual market makers present. Moreover, equity spreads for the dual market maker group are significantly (at the 1% level) lower (difference ranging from 0.05 to 0.15) than for non-dual market maker groups.

5. Conclusions and policy implications

This paper is the first to study the role of a financial intermediary that simultaneously serves as a lead arranger for a syndicated bank loan and acts as an equity market maker for the borrowing firm's

[17] We permit replacement for the $k = 1$ case, but not for the $k = 50$ and $k = 100$ cases so as to retain a sufficient number of non-dual market maker matches. While results are reported in this paper for one-to-one and one-to-many tests, Davies and Kim (2009) provide evidence that shows that, in general, one-to-one nearest neighbor matching typically performs better than one-to-many matching.

stock, denoted a dual market maker. The lead arranger of a syndicated bank loan possesses private information about the borrowing firm, typically obtained over the course of a long-term lending relationship. In addition, participating in the equity market allows the lead arranger to gain valuable and complementary information from the order flows. We consider the impact on market liquidity of the presence of such an informed market maker. We hypothesize that in a transparent competitive market with a lot of liquidity traders, such as the equity market, the informed dual market maker behaves as a natural liquidity provider and helps to reduce the bid-ask spread in the equity market. However, in an opaque and less competitive market such as the syndicated loan market, the information advantage of the dual market maker results in a higher spread. These effects should be more pronounced for small firms that tend to be informationally opaque.

Empirically, we analyze the equity and loan market liquidity in the presence of a dual market maker while accounting for the endogeneity of the choice to be a dual market maker. We find that the lead arranger of a syndicated bank loan is more likely to be an equity market maker when the profit opportunities of market making are high. This occurs when the dual market maker has a greater informational advantage over other equity market makers, when the equity market capitalization is large, and when the lead arranger has a larger market share in the loan market. Using a two-stage procedure, we find that the presence of a dual market maker reduces equity spreads, but increases loan spreads. Although these effects are found in our entire sample, they are only statistically significant for a subsample comprised of small firm borrowers.

Our analysis has major policy implications related to regulations on information flows within financial intermediaries – in particular, the possibility that dual market making violates insider trading laws. This is a murky area, in part, because ''securities laws neither provide a definition of 'insider trading' nor expressly forbid it'' (Eads, 1991, p. 1457). Indeed, Congress may have deliberately refused to precisely define insider trading so as to give the SEC more flexibility in enforcement. Recent court cases have developed the theory that insider trading involves misappropriation. '''Misappropriation trading' results when a trader exploits material, non-public information to trade securities and breaches a duty owed to the source of such information'' (Prakash, 1991, p. 1493). However, where the divider lies between legal and illegal activity is not always clear. It is unclear whether members of a loan syndicate owe a fiduciary duty to the borrower or even if they are privy to ''material'' information in a legal sense. Although this paper does not address the question of whether illegal trading activity is taking place, we demonstrate that the presence of global financial institutions, simultaneously trading in many financial markets, affects the liquidity and information efficiency of asset prices in these markets. Hence, we demonstrate that policy proposals regarding ''Chinese'' and ''ethical'' walls restricting the reusability of information within financial institutions should consider the potential impact on market efficiency.

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Appendix A:. Estimation of the simultaneous regression model

The simultaneous estimation of the structural Eqs. (1) and (2) is complicated by the fact that one dependent variable is continuous ($SPREAD_t$), whereas the other is discrete ($DUALMM_t$). Our estimation

technique corresponds to the two-stage procedure detailed in Maddala (1983, p. 242). In the first stage, we estimate the following reduced form models:

$$\text{SPREAD}_t = \prod_1 \text{X} + v_1 \tag{A.1}$$

and

$$\text{DUALMM}_t = \prod_2 \text{X} + v_2, \tag{A.2}$$

where v_1 and v_2 are the residuals associated with the reduced form models and X is a vector of all variables in X_1 and X_2. Because DUALMM_t is a dichotomous variable, we estimate $\prod_2/\sigma_2$, where $\sigma_2^2 = Var(v_2)$. We therefore rewrite the reduced form model (A.2) as:

$$\text{DUALMM}_t^* = \frac{\text{DUALMM}_t}{\sigma_2} = \frac{\prod_2}{\sigma_2}\text{X} + \frac{v_2}{\sigma_2} = \prod_2^* \text{X} + v_2^*, \tag{A.3}$$

and rewrite the structural Eqs. (1) and (2) by substituting $\frac{DUALMM_t}{\sigma_2}$ for $DUALMM_t^*$ as:

$$\text{SPREAD}_t = \gamma_1\sigma_2\text{DUALMM}_t^* + \beta_1'\text{X}_1 + e_1 \tag{A.4}$$

and

$$\text{DUALMM}_t^* = \frac{\gamma_2}{\sigma_2}\text{SPREAD}_t + \frac{\beta_2'}{\sigma_2}\text{X}_2 + \frac{e_2}{\sigma_2}, \tag{A.5}$$

We then estimate Eqs. (A.4) and (A.5) using a two-stage procedure. In the first stage, we estimate $\prod_1$ through ordinary least squares estimation of the reduced form model (A.1), and estimate $\prod_2^*$ through probit maximum likelihood estimation of the reduced form model (A.3). This results in the estimates $\hat{\prod}_1$ and $\hat{\prod}_2^*$. In the second stage, we substitute DUALMM_t^* with $\hat{\prod}_2^*\text{X}$ in the structural Eq. (A.4) and estimate the equation using ordinary least squares estimation. We then substitute SPREAD_t with $\hat{\prod}_1\text{X}$ in structural Eq. (A.5) and estimate the equation using probit maximum likelihood estimation.

The corrected variances associated with this methodology are derived as follows. Following a procedure similar to Amemiya (1979), Maddala (1983) derives the following asymptotic covariance matrix. Define $\alpha_1' = (\gamma_1\sigma_2, \beta_1')$ and $\alpha_2' = (\gamma_2/\sigma_2, \beta_2'/\sigma_2)$. The corrected variances are

$$Var(\hat{\alpha}_1) = c(H'X'XH)^{-1} + (\gamma_1\sigma_2)^2(H'X'XH)^{-1}H'X'XV_0X'XH(H'X'XH)^{-1}$$

and

$$Var(\hat{\alpha}_2) = (G'V_0^{-1}G)^{-1} + d(G'V_0^{-1}G)^{-1}G'V_0^{-1}(X'X)^{-1}V_0^{-1}G(G'V_0^{-1}G)^{-1},$$

where

$$c = \sigma_1^2 - 2\gamma_1\sigma_{12},$$

$$d = (\gamma_2/\sigma_2)^2\sigma_1^2 - 2(\gamma_2/\sigma_2)(\sigma_{12}/\sigma_2),$$

$$H = \left(\prod_2, J_1\right),$$

$$G = \left(\prod_2, J_2\right),$$

$$V_0 = Var\left(\widehat{\prod}_2\right),$$

and J_1 and J_2 are matrices of ones and zeros such that $XJ_1 = X_1$ and $XJ_2 = X_2$.

To implement the econometric model for the loan market spreads, we define X_1^{LOAN} and X_2^{LOAN} as:

$$X_1^{LOAN} = [\text{CONSTANT, EQUITYRETURN, LOANRETURN, RATEAISD, SECURED, ln(FACILITYSIZE), LN(NUMBSYN), EQUITYINDEXRETURN, LOANINDEXRETURN, PROBDEFAULT, DIFPROBDEFAULT, LAGDIFPROBDEFAULT, EQUITYVOLATILITY, LEVERAGE, EPS, ln(MARKETVALUE), TANGIBLE, INDUSTRY}] \quad (A.6)$$

$$X_2^{LOAN} = [\text{CONSTANT, LEADSHAREOFMARKET, INCOMETOA, RATEAISD, SECURED, ln(FACILITYSIZE), ln(NUMBSYN), EQUITYINDEXRETURN, LOANINDEXRETURN, PROBDEFAULT, DIFPROBDEFAULT, LAGDIFPROBDEFAULT, EQUITYVOLATILITY, LEVERAGE, EPS, ln(MARKETVALUE), TANGIBLE, INDUSTRY}] \quad (A.7)$$

where INDUSTRY represent the industry dummy variables FRENCH1–FRENCH12, excluding the base case reference dummies FRENCH4 and FRENCH12. All other variables are defined in the previous section.

The control variables in both equations are: SECURED, ln(FACILITYSIZE), ln(NUMBSYN), EQUITYINDEXRETURN, LOANINDEXRETURN, PROBDEFAULT, DIFPROBDEFAULT, LAGDIFPROBDEFAULT, EQUITYVOLATILITY, LEVERAGE, EPS, ln(MARKETVALUE), TANGIBLE, and INDUSTRY.

To estimate the simultaneous equation system for the equity spreads, we define:

$$X_1^{EQUITY} = [\text{CONSTANT, EQUITYRETURN, LOANRETURN, SECURED, ln(FACILITYSIZE), ln(NUMBSYN), EQUITYINDEXRETURN, LOANINDEXRETURN, PROBDEFAULT, DIFPROBDEFAULT, LAGDIFPROBDEFAULT, EQUITYVOLATILITY, LEVERAGE, EPS, ln(MARKETVALUE), TANGIBLE, INDUSTRY}] \quad (A.8)$$

$$X_2^{EQUITY} = [\text{CONSTANT, INCOMETOA, RATEAISD, SECURED, ln(FACILITYSIZE), ln(NUMBSYN), EQUITYINDEXRETURN, LOANINDEXRETURN, PROBDEFAULT, DIFPROBDEFAULT, LAGDIFPROBDEFAULT, EQUITYVOLATILITY, LEVERAGE, EPS, ln(MARKETVALUE), TANGIBLE, INDUSTRY}], \quad (A.9)$$

As discussed in Section 3.2.1, the list of variables in X_1 and X_2 for the loan spreads equation system and the equity spreads equation system is similar, except that the RATEAISD variable omitted in X_1^{EQUITY} and the LEADSHAREOFMARKET variable omitted in X_1^{EQUITY}.

References

Allen, F., Gale, D., 2000. Financial contagion. J. Polit. Economy 108, 1–33.

Allen, L., Gottesman, A.A., 2006. The informational efficiency of the equity market as compared to the syndicated bank loan market. J. Finan. Services Res. 30, 5–42.

Allen, L., Jagtiani, J., Peristiani, S., Saunders, A., 2004. The role of commercial bank advisors in mergers and acquisitions. J. Money, Credit, Banking 36, 197–224.

Allen, L., Peristiani, S., 2007. Loan underpricing and the provision of merger advisory services. J. Banking Finance 31, 3539–3562.

Altman, E., Gande, A., Saunders, A., 2010. Bank debt versus bond debt: evidence from secondary market prices. J. Money, Credit, Banking 42, 755–767.

Amemiya, T., 1979. The estimation of a simultaneous equation Tobit model. Int. Econ. Rev. 20, 169–181.

Anderson, T.W., 1951. Estimating linear restrictions on regression coefficients for multivariate normal distributions. Ann. Math. Stat. 22, 327–351.

Andrews, D.W.K., Stock, J.H., 2006. Inference with weak instruments. In: Blundell, R., Newey, W.K., Persson, T. (Eds.), Advances in Economics and Econometrics, Theory and Applications, 9th Congress of the Econometric Society, vol. 3. Cambridge University Press, Cambridge, UK (Chapter 6).

Angrist, J.D., Kruger, A., 2001. Instrumental variables and the search for identification: from supply and demand to natural experiments. J. Econ. Perspect. 15, 69–85.

Angrist, J.D., Imbens, G.W., 1995. Two-stage least squares estimation of average causal effects in models with variable treatment intensity. J. Amer. Statistical Assoc. 90, 431–442.

Bessembinder, H., 2003. Quote-based competition and trade execution costs in NYSE-listed stocks. J. Finan. Econ. 70, 385–422.

Bessembinder, H., Maxwell, W., 2008. Transparency and the corporate bond market. J. Econ. Perspect. 22, 217–234.

Benston, G.J., 1990. The Separation of Commercial and Investment Banking. Oxford University Press, Oxford.
Berger, A.N., Bouwman, C.H.S., 2009. Bank liquidity creation. Rev. Finan. Stud. 22, 3779–3837.
Bharath, S., Dahiya, S., Saunders, A., Srinivasan, A., 2007. So what do I get: a bank's view of lending relationships? J. Finan. Econ. 85, 368–419.
Bharath, S., Dahiya, S., Saunders, A., Srinivasan, A., 2011. Lending relationships and loan contract terms: does size matter? Rev. Finan. Stud. 24 (4), 1141–1203.
Biais, B., 1993. Price formation and equilibrium liquidity in fragmented and centralized markets. J. Finance 48, 157–185.
Biais, B., Martimort, D., Rochet, J.C., 2000. Competing mechanisms in a common value environment. Econometrica 78, 799–837.
Biais, B., Green, R., 2007. The Microstructure of the Bond Market in the 20th Century. Working Paper, Carnegie Mellon University.
Bodnaruk, A., Massa, M., Simonov, A., 2009. Investment banks as insiders and the market for corporate control. Rev. Finan. Stud. 22, 4989–5026.
Boot, A.W.A., 2000. Relationship banking: what do we know? J. Finan. Intermediation 9, 7–25.
Bound, J., Jaeger, D., Baker, R., 1995. Problems with instrumental variables estimation when the correlation between the instruments and the endogenous explanatory variable is weak. J. Amer. Statistical Assoc. 90, 443–450.
Brunnermeier, M.K., Pedersen, L.H., 2009. Market liquidity and funding liquidity. Rev. Finan. Stud. 22, 2199–2201.
Calcagno, R., Lovo, S., 2006. Bid-ask price competition with asymmetric information between market-makers. Rev. Econ. Stud. 73, 329–355.
Card, D.E., 1995. Earnings, schooling and ability revisited. In: Polacheck, S.W. (Ed.), Research in Labor Econ, vol. 14. JAI Press, Greenwich, CT and London, pp. 23–48.
Chordia, T., Roll, R., Subrahmanyam, A., 2002. Order imbalance, liquidity and market returns. J. Finan. Econ. 65, 111–130.
Chordia, T., Sarkar, A., Subrahmanyam, A., 2005. An empirical analysis of stock and bond market liquidity. Rev. Finan. Stud. 18, 85–129.
Chung, S.Y., Cho, K.H., 2005. Security analysis and market making. J. Finan. Intermediation 14, 114–141.
Coughenour, J.F., Saad, M.M., 2004. Common market makers and commonality in liquidity. J. Finan. Econ. 73, 37–70.
Cragg, J.G., Donald, S.G., 1993. Testing identifiability and specification in instrumental variables models. Econometric Theory 9, 222–240.
Davidson, R., MacKinnon, J., 1993. Estimation and Inference in Econometrics. Oxford University Press, New York.
Davidson, R., MacKinnon, J.G., 2004. Econometric Theory and Methods. Oxford University Press, New York.
Davies, R.J., Kim, S.S., 2009. Using matched samples to test for differences in trade execution costs. J. Finan. Markets 12, 173–202.
Dennis, S., Nandy, D., Sharpe, I.G., 2000. The determinants of contract terms in bank revolving credit agreements. J. Finan. Quant. Anal. 35, 87–110.
Dennis, S., Mullineaux, D., 2000. Syndicated loans. J. Finan. Intermediation 9, 404–426.
Drucker, S., Puri, M., 2005. On the benefits of concurrent lending and underwriting. J. Finance 60, 2763–2799.
Drucker, S., Puri, M., 2009. On loan sales, loan contracting and lending relationships. Rev. Finan. Stud. 22, 2835–2872.
Durbin, J., 1954. Errors in variables. Rev. Int. Statist. Inst. 22, 23–32.
Eads, L.S., 1991. From Capone to Boesky: Tax evasion, insider trading and the problems of proof. Calif. Law Rev. 79, 1421–1484.
Edwards, A.K., Harris, L.E., Piwowar, M.S., 2007. Corporate bond market transaction costs and transparency. J. Finance 62, 1421–1451.
Fight, A., 2004. Syndicated Lending. Elsevier, Amsterdam.
Gande, A., Saunders, A., 2006. Are banks still special when there is a secondary market for loans? SSRN Working Paper Series.
Glosten, L., Milgrom, P., 1985. Bid, ask, and transaction prices in a specialist market with heterogeneously informed traders. J. Finan. Econ. 13, 71–100.
Goldstein, M.A., Hotchkiss, E.S., Sirri, E.R., 2007. Transparency and liquidity: a controlled experiment on corporate bonds. Rev. Finan. Stud. 20, 235–273.
Goldstein, M.A., Nelling, E.F., 1999. Market making and trading in Nasdaq Stocks. Finan. Rev. 34, 27–44.
Gottesman, A.A., Roberts, G.S., 2007. Loan rates and collateral. Finan. Rev. 42, 401–427.
Green, R., Hollifield, B., Schurhoff, N., 2007. Financial intermediation and the costs of trading in an opaque market. Rev. Finan. Stud. 20, 275–314.
Grossman, S.J., Stiglitz, J.E., 1980. On the impossibility of informationally efficient markets. Amer. Econ. Rev. 70, 393–408.
Gujarati, D.N., 2003. Basic Econometrics. McGraw-Hill, New York.
Hall, A.R., Rudebusch, G.D., Wilcox, D.W., 1996. Judging instrument relevance in instrumental variables estimation. Int. Econ. Rev. 37, 283–298.
Harris, L.E., Piwowar, M.S., 2006. Secondary trading costs in the municipal bond market. J. Finance 61, 1361–1397.
Hausman, J., 1978. Specification tests in econometrics. Econometrica 46, 1251–1271.
Heckman, J.J., Ichimura, H., Todd, P.E., 1998. Matching as an econometric evaluation estimator. Rev. Econ. Stud. 65, 261–294.
Heckman, J., Vytlacil, E., 1998. Instrumental variables methods for the correlated random coefficient model: estimating the average rate of return to schooling when the return is correlated with schooling. J. Human Res. 33, 974–987.
Ho, T., Stoll, H., 1981. Optimal dealer pricing under transactions and return uncertainty. J. Finan. Econ. 9, 47–73.
Ivashina, V., 2009. Agency effects on syndicated loan rates. J. Finan. Econ. 92, 300–319.
Kanatas, G., Qi, J., 2003. Integration of lending and underwriting: implications of scope economies. J. Finance 3, 1167–1191.
Keys, B., Mukherjee, T., Seru, A., Vig, V., 2010. Did securitization lead to lax screening? Evidence from subprime loans. Quart. J. Econ. 125, 307–362.
Kroszner, R., Rajan, R., 1994. Is the Glass-Steagall Act justified? A study of the US experience with universal banking before 1933. Amer. Econ. Rev. 84, 810–832.
Kyle, A.S., 1985. Continuous auctions and insider trading. Econometrica 53, 1315–1336.
Kyle, A.S., Xiong, W., 2001. Contagion as a wealth effect. J. Finance 56, 1401–1440.
Ljungqvist, A., Marston, F., Wilhelm, W.J., 2006. Competing for securities underwriting mandates: banking relationships and analyst recommendations. J. Finance 61, 301–340.

Maddala, G.S., 1983. Limited-Dependent and Qualitative Variables in Econometrics. Cambridge University Press, Cambridge, MA.
Madureira, L., Underwood, S., 2008. Information, sell-side research and market making. J. Finan. Econ. 90, 105–126.
Mester, L., Nakamura, L., Renault, M., 2002. Checking Accounts and Bank Monitoring. Working Paper, Federal Reserve Bank of Philadelphia.
Michaely, R., Roberts, M.R., 2007. Corporate Dividend Policies: Lessons from Private Companies. Working Paper, University of Pennsylvania.
Naik, N., Neuberger, S., Viswanathan, S., 1999. Trade disclosure regulation in markets with negotiated trades. Rev. Finan. Stud. 12, 873–900.
Nandy, D., Shao, P., 2010. Institutional Investment in Syndicated Loans. Working Paper, York University.
Pagano, M., Röell, A., 1996. Transparency and liquidity: a comparison of auction and dealer markets with informed trading. J. Finance 51, 579–611.
Peng, L., Xiong, W., 2006. Investor attention, overconfidence and category learning. J. Finan. Econ. 80, 563–602.
Prakash, S., 1991. Our dysfunctional insider trading regime. Columbia Law Rev. 99, 1491–1550.
Puri, M., 1996. Commercial banks in investment banking: conflicts of interest or certification role? J. Finan. Econ. 40, 373–401.
Puri, M., 1999. Commercial banks as underwriters: implications for the going public process. J. Finan. Econ. 54, 133–163.
Puri, M., Rocholl, J., 2008. On the importance of retail banking relationships. J. Finan. Econ. 89, 253–267.
Pyles, M.K., Mullineax, D.J., 2008. Constraints on loan sales and the price of liquidity. J. Finan. Services Res. 33, 21–36.
Rosenbaum, P., Rubin, D., 1983. The central role of the propensity score in observational studies for causal effects. Biometrika 70, 41–55.
Rosenbaum, P., Rubin, D., 1985a. Constructing a control group using multivariate matched sampling methods that incorporate the propensity. Amer. Statistician 39, 33–38.
Rosenbaum, P., Rubin, D., 1985b. The bias due to incomplete matching. Biometrics 41, 103–116.
Saunders, A., Steffen, S., 2008. The Cost of Being Private: Evidence from Loan Markets. Working Paper, New York University.
Saunders, A., Stover, R.D., 2004. Commercial bank underwriting of credit-enhanced bonds: are there certification benefits to the issuer? J. Int. Money Finance 23, 367–384.
Schultz, P., 2003. Who makes markets? J. Finan. Markets 6, 49–72.
Staiger, D., Stock, J.H., 1997. Instrumental variables regression with weak instruments. Econometrica 65, 557–586.
Stock, J.H., Yogo, M., 2005. Testing for weak instruments in linear IV regressions. In: Andrews, D.W.K., Stock, J.H. (Eds.), Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg. Cambridge University Press, Cambridge, pp. 80–108.
Sufi, A., 2007. Information asymmetry and financing arrangements: evidence from syndicated loans. J. Finance 62, 629–668.
Wahal, S., 1997. Entry, exit, market makers and the bid-ask spread. Rev. Finan. Stud. 10, 871–901.
Wu, D., 1973. Alternative tests of independence between stochastic regressors and disturbances. Econometrica 41 (4), 733–750.
Yin, X., 2005. A comparison of centralized and fragmented markets with costly search. J. Finance 60, 1567–1590.