Liquidity, Competition & Price Discovery in the European Corporate Bond Market

Bruno Biais and Fany Declerck
Toulouse School of Economics

August 2007

Abstract

Using a new trades and quotes dataset, we study European corporate bonds. In this OTC market, Euro denominated bonds trade on average 4 times a day and Sterling bonds 1.5 times a day. Spreads increase with maturity, default risk and dealers' market power. For a €100 bond price, in 2005, effective spreads ranged from 12 cents for small trades to 8 cents for large ones. For Sterling bonds, effective spreads ranged from 28 to 15 pence. Greater competition and liquidity and tighter spreads in the Euro market reflect participation by investors and banks from many countries. Trades have significant information content, especially for bonds with low ratings. It takes at least five trading days for the information content of a trade to be fully impounded in market pricing, reflecting lack of post trade transparency.

This research benefited from financial support from INQUIRE, LIBA-ICMA-IMA & the Corporation of London. We are very grateful for data provided by David Mark and Mark Pralle, from IIC, David Self, from ICMA and Bassem Yahia from Bloomberg. We benefited from discussions with Ian Baillie, Samantha Barass, Jean François Boullier, François-Henri Brault, Richard Britton, Thierry Cazaux, Michael Fleming, Ken Garbade, Pascal Gilbert, Edith Hotchkiss, Jane Low, David Mark, Gordon Midgley, Pam Moulton, Géraud de Nadaillac, Carlos Pardo, Mark Pralle Richard Tuffier, David Self and participants at the NewYork Fed Research Seminar, the European Winter Finance Conference, the Oxford Finance Symposium, the European Summer Symposium in Financial Markets at Gerzensee and the EuroMTS conference on Fixed Income Markets.

Bonds play a very important role in the financing of our economies. In the US the capitalization of the bond market is roughly the same as that of the stock market. In Europe the former is larger than the latter. Hence, the liquidity of the bond market and its informational efficiency are key determinants of the financing of governments and firms. Several empirical studies offer interesting evidence about the government bond market (see e.g., Fleming & Remolona, 1999). It differs markedly from the corporate bond market, however. The Treasury market involves one powerful issuer, repeatedly tapping the market, for large and rather standardized issues. The corporate bond market involves a large number of diverse issuers, some rather small, infrequently tapping the market, often for non-standard bonds. These features of the corporate bond market impact its liquidity. In this paper, we focus on the secondary market for corporate bonds in Europe. Our goal is to understand the workings of this market and investigate its efficiency. Does it convey adequate information to economic agents? Is it liquid enough to avoid excessive cost of funds for issuing firms?

Several empirical studies have recently shed interesting light on the microstructure of the US corporate bond market (Hotchkiss and Ronen (2002), Chakravarty and Sarkar (2003), Edwards, Harris and Piwowar (2007), Goldstein, Hotchkiss and Sirri (2007), Bessembinder, Maxwell and Venkataraman (2006)). [i] Their estimates of the bid-ask spread tend to be larger than estimates obtained from the stock market.[ii] This is surprising, since bonds are less risky than stocks, and spreads increase with risk. This suggests that other characteristics of the microstructure of bond markets, such as transparency or competition, may be at play. The European corporate bond market differs from the US market regarding these variables. Hence, it offers an interesting opportunity to offer additional insights on bond markets, complementing those generated by studies of the US market.

First consider transparency. In the US, in 2002, regulation TRACE imposed post-trade transparency.[iii] Edwards, Harris and Piwowar (2007) estimate that this increase in transparency reduced the bid-ask spread by about 5 to 10 cents (for a bond price of $100.) Goldstein, Hotchkiss and Sirri (2007) compare spreads between bonds for which TRACE implied transparency and bonds for which it did not. They find that post-trade transparency induced a drop in spreads ranging between 0 and 55 cents. Bessembinder, Maxwell and Venkataraman (2006) find that even for institutional trades TRACE reduced spreads. In contrast, in Europe there is no post-trade transparency. This offers an opportunity to compare liquidity in an opaque market (Europe) to its counterpart in a transparent market (US), while keeping other variables constant (security type, year, rating, etc…).

Second, consider the competition between liquidity suppliers. In the US a relatively small number of very large banks dominate the market. In the UK also, because Sterling denominated bonds attract mostly British market participants, the number of investors and liquidity suppliers is limited. In contrast, in the Eurozone, the number of potential liquidity suppliers is large. The big international players (Morgan, Merill, Deutsche, etc…) are present in the market, along with the national champions from all the Eurozone countries (BNPParibas, Unicredito, ABN Amro, etc…). Thus, there will typically be around 20 active dealers for each reasonably liquid bond in this market. Comparing the US, UK and Eurozone markets thus offers an opportunity to shed light on the impact of competition on transactions costs.

Third, Europe offers an opportunity to assess the out of sample robustness of the results obtained for the US market, especially those that could sound surprising, in comparison to the stylized facts from stock markets: Do we observe relatively large spreads? Are spreads decreasing in trade size?

To conduct our analysis we rely on a new quotes and trades dataset, provided to us by the International Index Company (IIC) and the International Capital Market Association (ICMA). We observe a complete record of time-stamped trades along with daily closing quotes in 2003, 2004 and 2005 for more than 300 Euro-denominated bonds and more than 300 Sterling denominated bonds. Ratings in our sample vary from AAA to BBB; AA and BBB being the most frequent categories. In terms of industry structure the bonds we study are not very different from those in the US TRACE sample. The dataset we analyze contain 1,844,826 trades, for which we observe the exact time of the transaction, the price, the quantity, characteristics of the bond and an anonymized dealer code.

We find that Euro denominated bonds trade on average 4 times a day and Sterling bonds 1.5 times a day. Since Goldstein, Hotchkiss and Sirri (2007) find an average number of 1.1 trades per day, and Edwards, Harris and Piwowar (2007) 1.9 trades a day, our results suggests trading frequency is larger in the Eurozone market than in the US.

We find that the number of market makers participating in at least one trade during the year is above 25 for Euro-denominated bonds and above 15 for Sterling bonds. For Euro denominated bonds, the market share of the 5 most active dealers is around 40%, while it takes only 3 or 4 dealers to cover 40% of the market for a typical Sterling bond. Thus, there is more competition between liquidity suppliers in the Euro denominated market. But, even in that market, the largest dealers are likely to enjoy some market power.

For our sample of Euro-denominated bonds, we estimate that effective spreads ranged in 2005 from .12% for small trades to .08% for large ones, and in 2003 from .22% to .12%. Thus, effective spreads in the European corporate bond market decrease with trade size, as found in the US market by Edwards, Harris and Piwowar (2007) and Goldstein, Hotchkiss and Sirri (2007). Our results also suggest that effective spreads in the Euro zone don't appear to be larger than their post TRACE US counterparts. For 2003, Goldstein, Hotchkiss and Sirri (2007) find effective spreads ranging between 2.7% for retail trades and .3% for large trades while Edwards, Harris and Piwowar (2007) find effective spreads between .5% for retail trades $200,000 and .2% for large trades. Reasonably tight spreads in the Euro denominated market are consistent with the presence of a large pool of potential buyers and sellers, attracting relatively competitive dealer liquidity. In contrast, we find that effective spreads in the Sterling market are larger than in the Euro market. Relatively few investors are active in the Sterling market. This leads to low natural liquidity, which, in turn, attracts only a limited number of market makers and eventually leads to relatively large transactions costs.

We find that both quoted spreads and effective spreads increase with maturity and default risk, in line with the results of Edwards, Harris and Piwowar (2007) and Goldstein, Hotchkiss and Sirri (2007) for the US. We also find that spreads increase with dealers' market power. Controlling for other variables, our regression analysis estimates the difference in effective spreads between bonds for which the market share of the most active dealers was above 40% and other bonds. We find that, in 2003, such market power raised the effective spread by 5.6 cents for a bond price of €100. In 2004 and 2005 the corresponding figures were .45 cent and 1.63 cents.

Finally, we analyze the information content of trades, i.e., the amount by which the market value of a bond increases after a purchase or decreases after a sale. We find that the information content of trades is significant, especially for low rating bonds. For a Euro denominated BBB bond priced at €100, after a purchase the midquote would rise on average by 5 cents in 2003, 3 cents in 2004 and 1 cent in 2005. For a sterling denominated bond priced at £100, the increase was on average equal to 6 pence in 2003, 2004 and 2005. Such information effects account for a significant fraction of the spread.

We also find that, on the day of the trade, only a small portion of its information content is impounded in the market quote. It takes at least 5 trading days for the information content of the trade to be fully reflected in market pricing. Since there is no post-trade transparency on the day of the trade, only the dealer and his customer are informed of it. It takes a week for this information to percolate through the market.

The next section describes the institutional features of the European corporate bond market. Section II presents our dataset. Section III presents our empirical results. Section IV concludes.

I. Institutional Setting

A. Differences with stocks

There are several important differences between the microstructure of the bond market and that of the stock market.

First, the characteristics of bonds payoffs (redemption date, relative safety) tend to attract a specific type of investors: Pension funds and insurance companies are among the largest investors in bonds. They tend to follow buy and hold strategies. This limits the level of activity in the secondary market.

Second, at least in Europe, it’s difficult and costly to short sell bonds. This further reduces the liquidity of the bond market. When an issue is entirely, or in large part, in the hands of a buy and hold investor, it’s difficult to sell it.[iv]

Third, stock market activity is concentrated in a relatively small number of securities, which trade very frequently each day, while the others trade only infrequently. For example, 2,800 companies are quoted on the NYSE. On this market, the 100 most active stocks account for a little less than half the total trading volume. In contrast, the bond market is less concentrated. Each issuer has typically several bonds outstanding. Capitalization and trading are spread across thousands of securities. This difference in concentration induces differences in the ease with which counterparts can be located. In the stock market, most large operators have an interest in the most active securities which constitute the bulk of the market. In the bond market, large operators will typically have an interest only in a subset of securities. Hence, in the bond market, it can be a more difficult task to identify a counterpart than in the stock market.

These institutional features of the bond market tend to reduce its liquidity. The evidence reported below documents the extent to which they do.

B. Dealership

The European corporate bond market, like the US market, is an over-the-counter market, revolving around dealers and brokers. Suppose an institutional investor desires to trade a given bond. He or she will contact one or several dealers, telling them which bond he or she wants to trade, the desired quantity, and whether he or she wants to sell. The dealers will then make price offers for the whole trade. Eventually, the customer will trade with the best offer, or decide not to trade. After trading with customers, dealer often unwind at least part of their inventory with other dealers. Alternatively, the investor can contact a broker, who will direct the agents to interested counterparties. The sequencing can sometimes be reversed: Brokers or dealers can contact investors, informing them of trading opportunities, in given bonds, at given prices, and asking them if they would be interested in trading under those conditions.

Dealers are not rewarded by commissions. Their bid and ask prices are net prices. Of course, they implicitly factor in the compensation of the dealership services. Hence transactions costs will reflect the costs of market making, and also possibly the rents of the dealers. One of the goals of this paper is to study the consequences of competition on transactions costs.

Because of their permanent presence on the market, and thanks to the order flow and contacts they are exposed to, dealers and brokers are in a good position to cope with the informational problems arising in the bond market. They have private information about their recent trades and about who is interested in trading. One of the goals of the present paper is to study if there is evidence of such private information and how fast transactions related information gets impounded in market pricing.

C. Telephones and screens

Traditionally, institutional investors would call dealers on the phone, negotiate on the price, and then possibly call another dealer.[v] Or the customer would call a phone broker, who would call several dealers. The telephone technology limits the number of dealers the customer can contact simultaneously. This increases the search costs incurred by the customers when searching for the right counterpart or the right bond and limits their ability to let dealers compete with one another. This increases the rents of the dealers, particularly when they have private information about which bonds are currently traded and who trades them.

Both in Europe and the US, electronic communication now complements telephone. Investors, dealers and brokers communicate through Bloomberg screens and messaging systems. Investors can purchase access to real time information from Bloomberg. Dealers' quotes are disseminated on screens. These indicative quotes tend to be close to the prices at which trades can occur, but they do not directly convey information about the occurrence of trades or about transactions prices. In addition, bonds differ markedly in terms of activity, and this affects the availability of quotes. Bonds with headline news, or which have been recently issued, are actively traded. For such bonds numerous quotes are posted on Bloomberg screens. Dealers and brokers also frequently send messages to large institutional investors, via the Bloomberg system. Such messages provide indications of trading interest, with prices, size and direction. Other bonds are inactively traded. For such bonds, it is difficult – and sometimes impossible – to find significant quotes on Bloomberg screens. Recently, electronic trading platforms have developed. They can be put in place by a single dealer, offering its customer pricing information, or involve several dealers, as illustrated by MarketAxess (which is described in the appendix). But electronic trading platforms only amount for a small fraction of the corporate bond market, estimated by market participants to be around 3 or 4%.

D. Regulation

The European bond market is a decentralized dealer market, self regulated by the International Capital Market Association (ICMA).[vi] While some dealers are based in continental Europe, most operate from London. The FSA plays a key role in the regulation of the European bond market. Other regulators concerned with this market include the Autorité des Marchés Financiers (AMF) and the London Stock Exchange. All the dealers belonging to ICMA (i.e., the huge majority of the dealers in the European Corporate Bond market) have to report their trades to this self regulatory organisation, through a system known as TRAX. TRAX captures most of the inter-professional business in continental Europe and the UK. Retail trading conducted between European banks and small clients is usually not reported to TRAX. TRAX makes its information available to national regulators, such as the FSA in London or the AMF in Paris, which can use it for monitoring and surveillance.

E. Transparency and quote dissemination

Currently, the European corporate bond market is not post trade transparent, i.e., transactions prices are not publicly disseminated after trades took place. For retail investors and small institutions, there is little transparency. But, large investors can obtain quotes from dealers, and information disseminated by data vendors or via Bloomberg messaging. The International Index Company (IIC), which computes iBoxx indices, disseminates quotes information for hundreds of Sterling and of Euro-denominated bonds. 10 dealers (ABN Amro, Barclays Capital, BNP Paribas, Deutsche Bank, Dresdner Kleinwort Wasserstein, HSBC, JP Morgan, Morgan Stanley, Royal Bank of Scotland and UBS Investment Bank) transmit indicative bid and ask quotes to the Deutsche Börse every minute for every bond in the iBoxx universe. Once IIC receives this data, it conducts quality controls.[vii] Then average ask prices and bid prices are computed for each bond. IIC sells this data in real time through vendors such as Bloomberg, Telerate, Telekurs, Reuters, etc... In addition, daily closing prices can be freely observed on the IIC website. While the dealers' prices used by IIC are only quotes, not tradeable prices or transactions prices, it has been confirmed to us by market participants that they are quite representative of actual market pricing for institutional size trades. Dealers have little incentives to manipulate their quote reports, in particular because i) their reports are averaged with those of the others, ii) outliers are excluded by IIC from the computation of the average price, and iii) IIC does not disseminate individual, non-anonymous quotes. To ensure that the bonds in the index are roughly comparable, iBoxx includes only plain vanilla bonds, excluding sinking funds and callable bonds. Furthermore, for the Euro denominated segment of the market, only bonds with amount outstanding above € 500 million are included in the iBoxx universe. For Sterling denominated bonds, the cutoff is £ 100 million.

II. Data

A. Datasets

A.1. The IIC sample

The International Index Company gave us a complete history of daily, end of day, bid and ask quotes for Euro and Sterling denominated bonds, from January 2003 to September 2005. For 2005, we have this data for 1495 bonds, which are the entire universe of corporate bonds handled by IIC and included in its corporate bond indices. They represent the majority of the European investment grade, plain vanilla, and bond market. For Euro denominated bonds, the IIC sample includes 703 securities in 2003, 799 in 2004 and 832 in 2005. For Sterling denominated bonds, the IIC sample includes 620 securities in 2003, 678 in 2004 and 663 in 2005.

The bid and ask quotes are expressed with the convention of a nominal bond price of €100 or £100. Thus, except for zero-coupons, the bond prices in our data are typically between 90 and 110. The IIC data gives separately the bond bid and ask quotes and the accrued interest. The latter is a deterministic, pre-specified function of time, independent from the pricing behaviour of the dealers. This function exhibits discontinuities around coupon payment days. Thus, to work with smooth times-series, reflecting the behaviour of the traders in the marketplace, we focus on prices net of accrued interest.

A.2. The TRAX sample

ICMA provided us with transactions data from TRAX. To be able to use jointly the IIC quote data and the transactions data from TRAX, we asked ICMA to give us data for bonds included in the IIC sample. ICMA gave us a complete record of all trades from January 2003 to September 2005. The number of bonds in the TRAX sample for the three years is given in Table I. For these securities, we have a complete time stamped record of the transactions reports, with characteristics of the bonds (such as its ISIN number, its date of issuance, its maturity, and the name of the issuing company) and the trades (such as the price, the quantity, whether the dealer reporting the trade was selling or buying, and an anonymized dealer code, which enabled us to compute market shares, reported in the next section). To eliminate outliers and erratic observations we discarded the trades that were reported between 11:00 p.m. and 6:00 a.m., those with value traded below 100 (€ or £) or above above 20 millions (€ or £). We also eliminated a few observations for which the change in price since the last trade was outside the +10%, -10% range. After these eliminations, we have a dataset of 1,844,826 transactions.

B. Structure of the sample

B.1. Issue size

As mentioned above, the Euro denominated bonds in our sample have issue size greater than or equal to €500 million, while for Sterling denominated bonds the cut off is at £100 million. This differs somewhat from the sample analyzed by Goldstein, Hotchkiss and Sirri (2007) who consider bonds with issue size between $10 million and $1 billion. The average issue size for our Euro denominated bond sample is €895,180,671. For the Sterling denominated bonds it is (after conversion to Euros) €407,608,630. Thus, the Sterling bonds in our sample have smaller issue size on average than their Euro counterparts.

B.2. Industry

The structure of the sample in terms of industries is given in Table I. In both currencies, by far the most frequent industry is financials (around 45% for € and 55% for £). This is in line with the stylized fact that the fraction of corporate bonds issued by financial firms is quite large in Europe. This is comparable with the US sample of BBB bonds studied by Goldstein, Hotchkiss and Sirri (2007) where financials account for 44% of the bonds. Also in both currencies, the second most frequent industry in our sample is utilities (around 12% of the bonds for Euros or Sterlings). In comparison, in the US sample studied by Goldstein, Hotchkiss and Sirri (2007) around 20% of the bonds are issued by utilities. The third most frequent industry, for Euro denominated bonds, is telecommunications – a legacy from the bubble period. This differs from the Sterling and US samples.

B.3. Maturity and rating

Table II presents the structure of our samples in terms of rating and maturity at issuance. For each maturity and rating and for each currency, the table shows the number of bonds in the IIC sample and the number of bonds in the TRAX sample. Inspecting the table, one can see that our TRAX sample is quite representative of our IIC sample. (Note however that the number of bonds in our sample is much lower than in the samples analysed by Edwards, Harris and Piwowar (2007) and Goldstein, Hotchkiss and Sirri (2007), which included 16,746 and 5,503 bonds, respectively.)

For both currencies, the most frequent rating is A. AA and BBB-rated bonds also are frequent. There is only a small number of AAA. This differs, by construction from the sample of BBB US bonds analysed by Goldstein, Hotchkiss and Sirri (2007) and from the sample of bonds analysed by Edwards, Harris and Piwowar (2007), which included speculative grade bonds (with ratings lower than BBB). For Euro denominated bonds, the most frequent maturities at issuance are 5, 7 and 10 years. For Sterling denominated bonds, the most frequent maturities are 10 years, 15 years and 20 years. Thus, the Sterling denominated bonds tend to have longer maturities than their Euro counterparts.

Overall, these descriptive statistics suggest that our sample is relatively broad and quite representative of European investment grade bonds. While it includes a smaller number of bonds, it is not markedly different from the US samples studied by Goldstein, Hotchkiss and Sirri (2007) and Edwards, Harris and Piwowar (2007). Note also that our sample only includes plain vanilla bonds, like the sample of Goldstein, Hotchkiss and Sirri (2007), while that of Edwards, Harris and Piwowar (2007) includes bonds with complex features (callable, convertible, sinking, etc…).

III. Empirical Results

A. Trading activity

For each bond in the TRAX sample, we computed the average number of trades per day and per bond. Euro-denominated bonds trade on average 4.84 a day in 2003, 4.79 in 2004 and 3.95 in 2005. For Sterling bonds, the corresponding figures are 1.26, 1.91 and 1.63, respectively. These trading frequencies are low, relatively to their counterparts from the stock market. This reflects the features of bond markets mentioned above, especially that i) many institutional investors often buy and hold bonds without retrading them and that ii) liquidity is spread across a large number of bonds.

Note however that the Euro denominated bonds in our sample are more frequently traded than the US corporate bonds analysed by Goldstein, Hotchkiss and Sirri (2007) and Edwards, Harris and Piwowar (2007). Goldstein, Hotchkiss and Sirri (2007), focusing on BBB bonds, find an average number of 1.1 trades per day. This is lower than the average number of trades in our sample for BBB bonds, which is above 7 for Euros and 3 for Sterlings. Edwards, Harris and Piwowar (2007), study bonds spanning several ratings, and find an average number of trades per day equal to 1.9, again lower than what we find. This is all the more striking that our dataset, in contrast with those of Edwards, Harris and Piwowar (2007) and Goldstein, Hotchkiss and Sirri (2007) does not include the small trades. The latter, although small in terms of total dollar trading volume, account for more than half the number of trades in the TRACE sample.

Table III Panel A shows how the average number of trades varies with issue size. As expected, both for Euros and Sterlings, trades are more frequent for bonds with larger issue size. Sterling denominated bonds tend to have lower issue size and also trade less frequently on average. Panel B shows how the average daily number of trades varies with maturity. Bonds with maturity equal to 5 years or 10 years are relatively more frequently traded than other bonds, maybe because these bonds are viewed as benchmarks, on which trading is focussed. We also studied the relation between trading frequency and rating and found that AAA and BBB rated bonds trade more frequently than AA and A. This reflects the interaction of two countervailing effects. On the one hand, high rating can increase liquidity by reducing adverse selection. On the other hand, news is more frequent for riskier bonds, and investors react to news by trading.

For each bond in our TRAX sample, we also computed the average daily volume traded. For Euro denominated bonds, the average across bonds was € 4,590,669 in 2003, 3,959,877 in 2004 and 3,649,923 in 2005. For Sterling denominated bonds, the corresponding figures, converted in Euros, were 1,213,346 in 2003, 1,641,220 in 2004 and 1,538,373 in 2005. Thus, also in terms of volume, the Euro denominated market is larger than the Sterling market.

B. Market concentration

For the Euro-denominated bonds in our TRAX sample, the number of market makers participating in at least one trade during the year was 29 in 2003, 27 in 2004 and 24 in 2005. For the Sterling denominated bonds, the number of active dealers per bond was 18 in 2003 and 2004 and 16 in 2005.

Figure 1 plots, as a function of N, the market share of the N largest dealers. It shows that market concentration was larger for Sterling than for Euro bonds. For Euros, the average market share of the most active dealer in each bond was 12.48% in 2003, 9.04% in 2004 and 8.95% in 2005. For Sterling bonds, the market share of the most active dealer was on average 12.03% in 2003, 14.28% in 2004 and 14.74% in 2005. Furthermore, for Euro denominated bonds, the market share of the 5 most active dealers was on average 40.1% in 2003, 34.11% in 2004 and 34.61% in 2005. For Sterling denominated bonds, the corresponding figures were 53.7%, 54.9% and 54.2%. For the average Sterling bond, the 4 largest dealers made more than 40% of the trades.

Thus, while there was some competition in the market, with around 15 to 20 dealers participating in trades for each bond, the most active dealers were likely to enjoy some market power. Also, competition and dealer participation were more limited for Sterling bonds. These bonds have lower issue size and attract less many investors, this leads to less natural liquidity, and attracts less many dealers.

C. *Quoted spreads*

Consider the quotes in the IIC dataset. Denote the (end of day) ask and bid prices for bond *i* on day *t* by $A_{i,t}$ and $B_{i,t}$, respectively. The (end of day) midquote for that bond and that day is:

$$M_{i,t} = (A_{i,t} + B_{i,t})/2, \tag{1}$$

and the (proportional) quoted spread is:

$$S_{i,t} = (A_{i,t} - B_{i,t})/M_{i,t}. \tag{2}$$

Relying on the IIC dataset, we first computed, for each bond, and each day, the end of day closing (proportional) spread. Then for each bond in our IIC sample, we computed the average quoted spread and we studied the distribution of this average across bonds.

For Euro denominated bonds, we find that the average quoted spread is .3952% in 2003, .3008% in 2004 and .2815% in 2005. Thus, in 2005, the quoted bid-ask spread was equal to 28.15 cents, for a bond with nominal price equal to €100. For the Sterling denominated bonds, the corresponding figures were .6676%, .5026% and .4589% respectively. That quoted spreads are larger for the Sterling market is consistent with the above reported findings that trades are less frequent and market makers less numerous in this market.

To study the determinants of quoted spreads, for each year in our sample we regressed across bonds the average quoted spread onto characteristics of the bond: The log of the € issue size, an indicator variable taking the value 1 if the bond was denominated in Sterling, rating, industry, residual maturity, an indicator variable taking the value 1 if the market share of the most active dealer in this bond was above 40%.

The results are reported in Table IV. They indicate that quoted spreads in the European corporate bond market vary with economic forces, as suggested by theory.[viii] Market microstructure models of dealer markets imply that spreads should increase with the inventory bearing costs of the dealers (see e.g., Ho and Stoll, 1983, Biais, 1993, or the survey by Biais, Glosten and Spatt, 2005). Inventory costs increase with the risk that the value of the security will vary a lot. In the case of bonds, this risk increases with the maturity of the bond and its credit risk (proxied by its rating). Consistently with these implications of the theory, we find that quoted bid-ask spreads in the European corporate bond market increase with maturity and decrease with credit quality. Microstructure models also imply that spreads should be larger when the market is concentrated among a small number of market makers (see e.g., Biais, Martimort and Rochet (2000)). Consistently with this implication, the indicator variable taking the value 1 when the most active dealer covered more than 40% of the market is significantly positive for 2003 and 2005. Furthermore, quoted spreads are significantly decreasing in issue size. This reflects that bonds issued in larger amount have more holders and greater natural liquidity than small issues.

The indicator variable taking the value one when the bond is denominated in Sterling is not significant. This suggests that, for quoted spreads, there are no significant differences between Sterling and Euro bonds beyond differences in the observable characteristics taken into account in our regressions. The most significant of these differences are that bonds have longer maturities and smaller issue size and dealers have greater market power in the Sterling market.

D. *Effective spreads*

D.1. Method

Consider bond *i* on day *t* and the case where there is at least one trade for this bond during that day. Consider the n^{th} transaction reported for bond *i* on day *t* in the TRAX dataset. Denote the transaction price by: $P_{i,n,t}$ and the direction of the trade by: $Z_{i,n,t}$. $Z_{i,n,t}$ takes the value one if the customer purchases from the dealer and minus one if the customer sells to the dealer. Finally, denote the fundamental value of bond *i* by v_i. This is the risk adjusted discounted value of the cash flows to be distributed by the bond. Just before the n^{th} trade in bond *i* on day *t*, the expectation by the market of the fundamental value of the bond is:

$$V_{i,n,t} = \mathrm{E}[v_i \mid H_{i,n,t}^{-}]. \quad (3)$$

In markets without post-trade transparency, it is not straightforward to define the information set of the market. In our analysis, we take H_i to be the information common to the 10 large dealers contributing to Iboxx and we accordingly use the midquote $M_{i,t-1}$ (from the IIC dataset) as a proxy for the fundamental value. More precisely, we assume that:

$$M_{i,t-1} = \mathrm{E}[v_i \mid H_{i,t-1}] = \mathrm{E}(V_{i,n,t} \mid H_{i,t-1}), \quad (4)$$

where $H_{i,t-1}$ is the information set of the market at the end of day *t-1*. Thus we have:

$$\mathrm{E}[v_i \mid \mathrm{H}_{i,n,t}^{-}] = M_{i,t-1} + \varepsilon_{i,n,t}, \quad (5)$$

where $\varepsilon_{i,n,t}$ is the informational innovation from the end of day *t-1* to the time of the n^{th} trade on day *t*. By definition: $\mathrm{E}(\varepsilon_{i,n,t} \mid H_{i,t-1})=0$. We also assume that $\mathrm{E}(\varepsilon_{i,n,t} Z_{i,n,t} \mid H_{i,t-1})=0$, i.e., trades direction is unpredictable, as in Kyle (1985).

The effective half-spread for this transaction is:

$$Z_{i,n,t} (P_{i,n\,t} - V_{i,n,t}) = Z_{i,n,t} (P_{i,n\,t} - M_{i,t-1}) + Z_{i,n,t}\ \varepsilon_{i,n,t}. \quad (6)$$

Note that:

$$\begin{aligned} \mathrm{E}[Z_{i,n,t} (P_{i,n\,t} - V_{i,n,t})] &= \mathrm{E}[\mathrm{E}\{Z_{i,n,t} (P_{i,n\,t} - V_{i,n,t}) \mid H_{i,t-1}\}] \\ &= \mathrm{E}[\mathrm{E}\{ Z_{i,n,t} (P_{i,n\,t} - M_{i,t-1}) + Z_{i,n,t}\ \varepsilon_{i,n,t} \mid H_{i,t-1}\}] \quad (7) \end{aligned}$$

$$= E[E\{ Z_{i,n,t} (P_{i,n\,t} - M_{i,t-1})|H_{t-1}\}] = E[Z_{i,n,t} (P_{i,n\,t} - M_{i,t-1})].$$

Thus, we use the empirical average of $Z_{i,n,t}$ ($P_{i,n\,t}$ - $M_{i,t-1}$) to estimate the effective half-spread. Note that to compute this we use both data from TRAX (for $Z_{i,n,t}$ and $P_{i,n\,t}$) and data from IIC (for $M_{i,t-1}$).

Some bonds in our data have different price levels than others. For example, while most prices in our data are around 100 (corresponding to a nominal of 100), we have some zero-coupons, with prices much below 100. To ensure comparability of the results across bonds with potentially different price levels, we normalize the variables by the previous days' midquote. Thus, we consider proportional effective spreads.

D.2. Results

For Euro denominated bonds, we find an average effective spread equal to .169% in 2003, .073% in 2004 and .10% in 2005. For Sterling bonds, the corresponding figures are .411%, .211% and .202% respectively.[ix] Thus, in line with our above reported findings on quoted spreads, effective spreads are tighter for Euro than for Sterling bonds.

In both currencies, the effective spread is tighter than the quoted spread. This was to be expected. Consider the case of an investor who wants to buy a bond. Suppose the 10 best dealers in the market are those who post quotes on IIC. Assume the customer runs an auction between these 10 dealers. Suppose the dealers' offers to the customer are equal to their IIC quotes. Then the customer will choose to trade at the best ask, which is the minimum of these ten quotes. This minimum will by construction be lower than the average of the ten ask quotes. The effective spread is computed on the basis of this minimum ask quote, while the quoted spread is computed based on the average ask quote.

To study the determinants of effective spreads, we regressed them onto characteristics of the bond. We used the same set of regressors as for quoted spreads: Log of issue size, an indicator for Sterling, rating, industry, residual maturity and market power.

Table V presents the results. Similarly to quoted spreads, effective spreads in the European corporate bond market decrease with issue size and increase with maturity, default risk and dealer market power. Our finding that effective spreads and quoted spreads tend to react similarly with economic forces suggests that the two datasets used to construct these variables (IIC and TRAX) consistently capture similar phenomena. Our regression analysis enables one to evaluate the consequences of an increase in market power, controlling for other variables. More precisely, it estimates the difference in spreads between bonds for which the market share of the most active dealer was above 40% and other bonds. The results in Table V show that, for a bond price of €100, market power raised the effective spread by 5.6 cents in 2003, .45 cent in 2004 and 1.63 cents in 2005.

In contrast with quoted spreads, for effective spreads the indicator variable taking the value one when the bond is denominated in Sterling is significant. This suggests that, after controlling for longer maturity, smaller issue sizes and greater dealer market power, the Sterling market is still less liquid than its Euro counterpart. This is likely to reflect the smaller number of market participants.

Table VI presents effective spreads by trade size. In line with the analyses conducted by Goldstein, Hotchkiss and Sirri (2007) and Edwards, Harris and Piwowar (2007) for the US bond market, we find that spreads decreased with trade size for the Sterling market and also for the Euro market in 2003 and 2004. Our findings on the relationship between spreads and maturity are consistent with those of Goldstein, Hotchkiss and Sirri (2007) and Edwards, Harris and Piwowar (2007). Our results are also consistent with the result, by Edwards, Harris and Piwowar (2007), that spreads decrease as credit risk decreases. This suggests that the economics of the secondary markets for bonds are not fundamentally different in Europe and in the US.

On the other hand, our estimates of effective spreads in the Euro market are lower than corresponding estimates from the US market. For bonds with a wide range of ratings, Edwards, Harris and Piwowar (2007) find average effective spreads of .54% for trade sized at $200,000 and spreads of .22% for trades sized at $1,000,000. This is above the effective spreads we find for the Euro market in 2003, which range from .218% for retail trades to .118% for large institutional trades.

To facilitate the comparison between the European market and the US market, we also studied a sub-sample of our data that is closely comparable to the dataset studied by Goldstein, Hotchkiss and Sirri (2007). This sub-sample includes only data from 2003, and only BBB bonds with issue size below one billion dollars. The 51 Euro denominated bonds and 85 Sterling denominated bonds in this sub-sample are very similar, in terms of rating, industry and issue size to those analyzed by Goldstein, Hotchkiss and Sirri (2007). The results are reported in Table VII. For comparison, the table also reports the effective spreads estimated for their sample of transparent bonds by Goldstein, Hotchkiss and Sirri (2007, Table VII). The findings in Table VII suggest that effective spreads in 2003 were lower in the European market for Euro denominated bonds than in the post-TRACE transparent market. Consider two examples, towards the extremes of the trade size spectrum: For retail trades, sized between $10,000 and $20,000, the average effective spread for Euro denominated bonds was .40%, while in the TRACE data it was 2.34%. For relatively large trades, sized between $250,000 and $1,000,000, the average effective spread was .16% for Euro denominated bonds and .37% for TRACE transparent bonds.

Along with our finding that trading frequency is greater for our sample of European bonds than for the TRACE samples analysed by Goldstein, Hotchkiss and Sirri (2007) and Edwards, Harris and Piwowar (2007), these results suggest the European corporate bond market is relatively liquid compared to its US counterpart. This is likely to reflect the integration of financial markets in the Eurozone. Investors and banks from all the Eurozone countries can trade in bonds from all these countries. This increases the number of potential investors as well as the number of dealers, resulting in greater liquidity.

E. Information content of trades

E.1. Method

From a theoretical standpoint trades in the corporate market might well reflect private information. Bonds are, by construction less sensitive than stocks to the performance of the firm.[x] Yet, as long as there is default risk, changes in the performance of the firm should impact the value of the bond. Thus, traders with superior information about the performance of the issuing firm should use the bond market, along with the stock market, as a vehicle for their trades. This is especially true for bonds with low ratings. The information content of the n^{th} trade in bond *i* on day *t* can be expressed as:

$$E[Z_{i,n,t} (E[v_i | H_{i,n,t}^+] - E[v_i | H_{i,n,t}^-])], \quad (8)$$

where $H_{i,n,t}^+$ is the information set of the market just after the trade. In words, the information content of the trade is the product between the change in assessment of the value of the bond and the direction of the trade. If purchases (resp. sales) convey positive (resp. negative) signals about the value of the bonds, then, when $Z_{i,n,t}$ = +1 (resp. -1), there will be an increase (resp. decrease) in the market expectation of the value of the bond and $E[v_i | H_{i,n,t}^+]$ will be above (resp. below) $E[v_i | H_{i,n,t}^-]$). Hence the product in (8) will be positive on average, and the expectation bounded above 0. In contrast, if the direction of trades conveys no systematic information to the market, and thus are independent from changes in assessments of the value of the bond, the expectation in (8) will be equal to 0.

Similarly to the previous subsection, we write,

$$M_{i,t} = E[v_i | H_{i,n,t}^+] + \eta_{i,n,t}, \quad (9)$$

where $\eta_{i,n,t}$ is the informational innovation from just after the trade until the end of day t ($E(\eta_{i,n,t} | H_{i,n,t}^+)=0$). Hence, the informational content of the trade rewrites as:

$$E[Z_{i,n,t} ((M_{i,t} - M_{i,t-1}) - (\eta_{i,n,t} + \varepsilon_{i,n,t}))]. \quad (10)$$

By construction, $\eta_{i,n,t}$ is unpredictable conditionally on $H_{i,n,t}^+$. Hence:

$$E[Z_{i,n,t} \eta_{i,n,t}]=0. \quad (11)$$

We maintain the assumption that $E[Z_{i,n,t} \varepsilon_{i,n,t}| H_{i,n,t,}]=0$. Hence, we estimate the information content of trades with the empirical average of $Z_{i,n,t} (M_{i,t} - M_{i,t-1})$. As in the analysis of effective spreads, to ensure comparability of the results across bonds with potentially different price levels, we normalize the variables by the previous day midquote.

Since there is no post-trade transparency, market quotes (which average the quotes of the 10 Iboxx contributors) may take more than one day to impound the informational content of the trade. Indeed, when one dealer conducts a trade, only this dealer and his customer are informed of it. To estimate how long it takes for the market to incorporate the information contained in the trade, we compute 5 different measures of the information content of trades. Suppose the trade occurs on Monday, the average of $Z_{i,n,t} (M_{i,t} - M_{i,t-1})$ measures the information content of this trade by comparing the previous day's quote (from Friday) to the closing quote on Monday. The average of $Z_{i,n,t} (M_{i,t+1} - M_{i,t-1})$ is a similar measure using the closing quote from the next day (Tuesday in our example). Similarly, we also compute information content measures using $M_{i,t+2}$, $M_{i,t+3}$, $M_{i,t+4}$, and $M_{i,t+5}$ (corresponding to Wednesday, Thursday, Friday and Monday in our example).

E.2. Findings

Our results are graphically represented in Figure 2. Quite remarkably, for both currencies and for the three years, our measure of information content rises with the horizon. On the day of the trade, only a small portion of its information content is impounded in the closing quote. An additional fraction of the information gets incorporated in the quotes the next day. And this continues during 5 days! Such slow incorporation of trading information into prices is due to the lack of post-trade transparency. When the trade occurs, only the trading dealer and the customer are informed of it. It takes at least a week for the rest of the market to learn this information.

Figure 2 also shows that the information content of trades is greater for bonds with greater default risk, as implied by theory. In Panels A, B, D, E and F, bonds rated BBB have the highest information content of trades. In Panel C they have the second highest. Also, the information content of trades is larger in the Sterling market than in its Euro counterpart. For BBB bonds it is significantly higher than 5 pence for a £100 bond price, which is almost one-half of the effective spread. Higher information content for Sterling trades could reflect that, for Euro denominated bonds, there is more publicly available information, for example more research or more analysts following. Correspondingly there would be less information asymmetry.

In general it’s difficult to disentangle information effects from inventory effects. But, in our case, it’s highly unlikely that our estimator of the information content of trades picks up inventory effects. First, to estimate it we rely on IIC quotes, which are obtained by averaging the quotes of 10 large dealers. Thus, even if the trading dealer is one these 10 market makers, the inventory impact of his trade on his price is diluted in the averaging of 10 quotes. Second, the impact of inventory on prices decreases with time, as the dealer unwinds his inventory. This contrasts with our finding that the information content of trades increases over the course of 5 days. Our finding that trades impact midquotes for at least a week is in line with

Hasbrouck's (1991) analysis of the information content of trades in terms of permanent price impact.

IV. Conclusion

This paper offers a first study of the microstructure of the European corporate bond market. Some of our findings are in tune with those obtained by previous studies, relying on the TRACE data, from the US market (see Edwards, Harris and Piwowar (2007), Goldstein, Hotchkiss and Sirri (2007) and Bessembinder, Maxwell and Venkataraman (2006)): Bid ask spreads in the European corporate bond market increase with inventory bearing costs, as predicted by theory. They also decrease with trade size and with issue size.

Our study also offers new results:

- We document how transactions costs in European corporate bond markets increase with dealers' market power.
- We also find that effective spreads are tighter and liquidity supply is more competitive for Euro denominated bonds than for Sterling denominated ones.
- And we find that spreads for Euro denominated bonds compare favourably to their TRACE transparent US counterparts.

We interpret these findings as suggesting that financial and monetary integration has spurred investors' participation and competition between banks from different Eurozone countries, resulting in greater liquidity.

Another contribution of this paper is to document the information content of trades in European corporate bonds. We find evidence of such information effects, especially for low rating bonds. We also find that it takes on average at least 5 trading days for the information content of trades to be fully impounded in market pricing. Such a long delay is likely to be due to the lack of post-trade transparency in the European market. It would be extremely instructive to run in that market an experiment similar to TRACE (which has been studied by Edwards, Harris and Piwowar (2007), Goldstein, Hotchkiss and Sirri (2007) and Bessembinder, Maxwell and Venkataraman (2006)). Our analysis suggests that such an increase in transparency would accelerate the incorporation of transactions related information into market pricing.

References

Biais, B., L. Glosten and C. Spatt, 2005, Microstructure: A survey of microfoundations, empirical results and policy implications, *Journal of Financial Markets*, 217-264.

Biais, B., 1993, Price formation and equilibrium liquidity in centralized and fragmented markets, *Journal of Finance*, 157-185.

Biais, B., and T. Mariotti, 2005, Strategic liquidity supply and security design, *Review of Economic Studies*, 615-650.

Biais, B., D. Martimort and J.C. Rochet, 2000, Competing mechanisms in a common value environment, *Econometrica*, 799-837.

Bessembinder, H., W. Maxwell, and K. Venkataraman, 2006, Market transparency and institutional trading costs, *Journal of Financial Economics*, 251-288.

Chakravarty, S., and A. Sarkar, 2003, Trading costs in three US bond markets, *Journal of Fixed Income*, 39-48.

DeMarzo, P. and D. Duffie, 1999, A Liquidity-Based Model of Security Design, *Econometrica*, 65-99.

Edwards, A., L. Harris and M. Piwowar, 2007. Corporate Bond Market Transparency and Transaction Costs, forthcoming, *Journal of Finance*.

Fleming, M., and E. Remolona, 1999, Price formation and liquidity in the US Treasury market: The response to public information, *Journal of Finance*, 1901-15.

Goldstein, M., E. Hotchkiss and E. Sirri, 2007, Transparency and Liquidity: A Controlled Experiment on Corporate Bonds, *Review of Financial Studies*, 235-273.

Green, R., B. Hollifield and N. Shurhoff, 2007, Financial Intermediation and the Costs of Trading in an Opaque Market, *Review of Financial Studies*, 275-314.

Harris, L., and M. Piwowar, 2004, Secondary trading in the municipal bond market, forthcoming, *Journal of Finance*.

Hasbrouck, J., 1991, Measuring the information content of stock trades, *Journal of Finance*, 179-207.

Hotchkiss, E., and T. Ronen, 2002, The Informational Efficiency of the Corporate Bond Market: An intraday Analysis, *Review of Financial Studies*, 1325-1354.

Kyle, A.S., 1985, Continuous auctions and insider trading, *Econometrica*, 1315-1335.

Myers., S. and N. Majluf, 1984, Corporate financing and investment decisions when firms have information investors do not have, *Journal of Financial Economics*, 187-221.

Schultz, P., 2001, Corporate Bond Trading Costs and Practice: A Peek behind the Curtain, *Journal of Finance*, 677-698.

Table I

Number of bonds in our TRAX sample, for different industries

For each currency and year, and for each of the 9 industries considered, the Table reports the number of bonds in our sample as well as the proportion of the sample corresponding to that industry.

Panel A: Euro denominated bonds

	2003		2004		2005	
	Number of bonds	% of sample	Number of bonds	% of sample	Number of bonds	% of sample
Basic Materials	10	4%	22	4%	22	4%
Consumer Goods or Services	51	18%	103	18%	100	16%
Financials	121	43%	264	45%	288	46%
Health Care	1	0%	5	1%	4	1%
Industrials	21	7%	44	7%	46	7%
Oil & Gas	8	3%	18	3%	20	3%
Technology	1	0%	2	0%	3	0%
Telecommunications	36	13%	51	9%	56	9%
Utilities	32	11%	78	13%	81	13%
	281		587		620	

Panel B: Sterling denominated bonds

	2003		2004		2005	
	Number of bonds	% of sample	Number of bonds	% of sample	Number of bonds	% of sample
Basic Materials	6	2%	7	1%	7	1%
Consumer Goods or Services	54	16%	87	17%	88	17%
Financials	182	55%	294	58%	316	59%
Health Care	2	1%	2	0%	2	0%
Industrials	23	7%	29	6%	29	5%
Oil & Gas	5	2%	13	3%	14	3%
Technology	1	0%	1	0%	1	0%
Telecommunications	12	4%	18	4%	17	3%
Utilities	44	13%	55	11%	58	11%
	329		506		532	

Table II

Structure by maturity & rating of the IIC & TRAX samples in 2005

Panel A

Number of Euro Denominated Bonds in the IIC & TRAX 2005 samples

The first four columns (AAA, AA, A and B) refer to bonds which kept the same rating. In each cell, the first figure is the number of bonds in the IIC sample, while the second figure (in parentheses) is the number of bonds in the TRAX sample. The next four columns (AA to A, A to AA, A to BBB, and BBB to A) refer to bonds in the IIC sample which changed rating during the sample period. In the last row and the last column, the first figure gives the number of bonds in the IIC sample, while the second figure (in parentheses) gives the number of bonds in the TRAX sample.

	AAA		AA		A		BBB		AA/AAA		A/AA		A/BBB		Total	
1																
2					2										2	(0)
3	2		1	(1)	1	(1)	6	(6)							10	(8)
4	6	(5)			1		1	(1)					1		9	(6)
5	15	(11)	27	(18)	64	(43)	59	(36)			2		1	(1)	168	(109)
6			3	(3)	10	(8)	2	(2)							15	(13)
7	7	(6)	10	(8)	59	(42)	92	(66)	1		2	(2)	2	(2)	173	(126)
8	1				3	(3)	2	(1)					1		7	(4)
9																
10	8	(5)	70	(49)	186	(151)	87	(71)			3	(2)	1	(1)	355	(279)
15			11	(9)	30	(27)	7	(6)			1				49	(42)
20			2	(1)	17	(17)	6	(4)							25	(22)
Longer			5	(1)	7	(5)	7	(5)							19	(11)
Total	39	(27)	129	(90)	380	(297)	269	(198)	1	(0)	8	(4)	6	(4)	832	(620)

Table II (Contd.) - Panel B

Number of Sterling Denominated Bonds in the IIC & TRAX 2005 samples

The first four columns (AAA, AA, A and B) refer to bonds which kept the same rating from. In each cell, the first figure is the number of bonds in the IIC sample, while the second figure (in parentheses) is the number of bonds in the TRAX sample. The next columns (AA to A, A to AA, A to BBB, and BBB to A) refer to bonds in the IIC sample which changed rating during the sample period. In the last row and the last column, the first figure gives the number of bonds in the IIC sample, while the second figure (in parentheses) gives the number of bonds in the TRAX sample.

	AAA		AA		A		BBB		AA/AAA		A/AA		A/BBB		Total	
1																
2	1	(1)	4	(3)	2	(2)	1								8	(6)
3	3	(2)	6	(4)	11	(11)	5	(5)							25	(22)
4	3	(3)	7	(7)	1	(1)	1	(1)							12	(12)
5	4	(4)	17	(14)	13	(10)	4	(3)							38	(31)
6	3	(3)	5	(4)	7	(5)	6	(3)							21	(15)
7	1	(1)	4	(4)	15	(10)	10	(7)							30	(22)
8			1	(1)	2	(2)	4	(3)							7	(6)
9			4	(3)			2	(1)							6	(4)
10	10	(10)	33	(23)	60	(50)	71	(56)			2	(2)	1	(1)	177	(142)
15	3	(3)	10	(9)	46	(41)	37	(27)			1	(1)	1	(1)	98	(82)
20	6	(5)	16	(15)	48	(41)	23	(15)							93	(76)
Longer	12	(10)	30	(19)	70	(56)	36	(29)							148	(114)
Total	46	(42)	137	(106)	275	(229)	200	(150)			3	(3)	2	(2)	663	(532)

Table III

Average daily number of trades in the TRAX sample

Panel A

Average daily number of trades by issue size

For each bond we computed the average numbed of trades per day. Then, we computed the cross sectional mean of these averages for each issue size category (for Sterling denominated bonds, we converted Sterling amounts into €, using the exchange rate prevailing at the beginning of the year).

	Euro denominated bonds			**Sterling denominated bonds**		
	2003	2004	2005	2003	2004	2005
All bonds	4.84	4.79	3.95	1.26	1.91	1.63
€ (0-200.000.000]	-	-	-	0.31	0.35	0.31
€ (200.000.000-300.000.000]	-	-	-	0.72	1.00	0.85
€ (300.000.000-400.000.000]	-	-	-	1.28	1.43	1.38
€ (400.000.000-500.000.000]	1.83	2.75	2.02	1.49	2.21	1.81
€ (500.000.000-600.000.000]	1.81	2.71	2.09	2.54	3.07	2.47
€ (600.000.000-700.000.000]	2.58	3.43	2.56	2.06	3.59	3.04
€ (700.000.000-800.000.000]	3.96	4.18	2.94	2.45	3.44	2.94
€ (800.000.000-900.000.000]	4.22	3.29	4.53	2.31	3.63	2.64
€ (900.000.000-1.000.000.000]	4.32	5.22	4.44	2.11	5.05	2.97
Above €1.000.000.000	10.97	9.61	8.63	2.74	3.80	3.79

Table III (Contd.) - Panel B

Average daily number of trades by maturity

For each bond we computed the average numbed of trades per day. Then. we computed the cross sectional mean of these averages for each maturity category. The categories are defined in terms of maturity at issuance.

	Euro denominated bonds			**Sterling denominated bonds**		
	2003	2004	2005	2003	2004	2005
All bonds	4.84	4.79	3.95	1.26	1.91	1.63
1	-	-	-	-	-	-
2	-	-	-	-	3.49	1.51
3	9.07	8.76	9.38	-	4.14	2.14
4	11.23	4.38	3.69	0.88	3.80	2.68
5	7.54	5.95	5.21	2.00	2.80	2.00
6	5.63	8.57	5.00	3.95	4.49	4.99
7	4.04	4.63	3.52	1.90	2.52	2.85
8	15.85	7.16	5.47	0.82	1.50	2.08
9	-	-	-	0.93	1.49	0.91
10	3.59	3.81	3.20	1.67	1.98	2.01
15	2.12	3.96	2.85	1.00	1.61	1.17
20	4.43	6.23	4.88	0.62	1.24	0.82
Longer	10.07	11.35	12.06	0.90	1.21	1.06

Table IV

Regression of quoted spread on bond characteristics

For each bond we computed the average quoted spread. We then regressed this average across bonds onto predetermined variables: issue size (in €), an indicator variable taking the value 1 if the bond was denominated in Sterling, rating dummies, industry dummies, residual maturity and an indicator variable taking the value 1 if the market share of the most active dealer in this bond was above 40%.

	2003		2004		2005	
	Estimate	T-value	Estimate	T-value	Estimate	T-value
Intercept	0,031464	6,94	0,023764	13,12	0,014151	8,24
Issue size	-0,001380	-6,37	-0,001100	-12,66	-0,000641	-7,76
Sterling	-0,000362	-1,02	-0,000058	-0,45	-0,000049	-0,41
AAA	-0,003063	-5,76	-0,001206	-6,44	-0,001159	-6,72
AA	-0,002671	-8,13	-0,000687	-5,12	-0,000745	-5,96
A	-0,002307	-9,19	-0,000700	-6,86	-0,000747	-7,84
Residual maturity	0,000225	14,37	0,000188	29,57	0,000221	37,14
Market share of most active dealer above 40%	0,001128	3,75	-0,000210	-1,95	0,000351	3,25
Basic Materials	0,000365	0,51	0,000403	1,39	0,000616	2,24
Consumer Goods	0,000054	0,12	0,000063	0,34	0,000846	4,81
Financials	0,001208	2,81	0,000535	2,96	0,000375	2,25
Health Care	0,000312	0,21	0,000621	1,19	0,000623	1,16
Industrials	0,001461	2,77	0,000704	3,13	0,001010	4,80
Oil and Gas	0,001147	1,49	0,000864	3,00	0,000827	3,13
Technology	0,007210	4,11	0,001811	2,35	0,001668	2,60
Utilities	0,001008	2,13	0,000652	3,23	0,000680	3,63
R^2	0,5026		0,6188		0,6449	

Table V

Regression of effective spreads on bond characteristics

For each bond, we computed the effective quoted spread. We then regressed this average across bonds onto predetermined variables: issue size (in €), an indicator variable taking the value 1 if the bond was denominated in Sterling, rating dummies, industry dummies, residual maturity and an indicator variable taking the value 1 if the market share of the most active dealer in this bond was above 40%.

	2003		2004		2005	
	Estimate	T-value	Estimate	T-value	Estimate	T-value
Intercept	0,005983	2,32	0,003754	3,22	0,002294	2,10
Issue size	-0,000273	-2,21	-0,000180	-3,21	-0,000101	-1,92
Sterling	0,000404	1,99	0,000320	3,84	0,000210	2,74
AAA	-0,000247	-0,82	-0,000477	-3,96	-0,000429	-3,91
AA	-0,000751	-4,02	-0,000212	-2,46	-0,000200	-2,52
A	-0,000590	-4,13	-0,000275	-4,19	-0,000359	-5,93
Residual maturity	0,000060	6,78	0,000040	9,72	0,000041	10,99
Market share of most active dealer above 40%	0,000538	3,14	0,000049	0,70	0,000166	2,43
Basic Materials	0,000606	1,49	0,000366	1,97	0,000223	1,28
Consumer Goods	0,000419	1,67	0,000230	1,91	0,000352	3,15
Financials	0,000459	1,88	0,000172	1,48	0,000162	1,53
Health Care	-0,000072	-0,09	0,000268	0,80	-0,000004	-0,01
Industrials	0,000345	1,15	0,000227	1,57	0,000302	2,26
Oil and Gas	0,000563	1,28	0,000183	0,99	0,000186	1,11
Technology	0,002403	2,41	0,000596	1,20	0,000352	0,86
Utilities	0,000574	2,13	0,000114	0,88	0,000202	1,70
R^2	0,2555		0,2271		0,2097	

Table VI

Effective spreads by trade size for the entire European bonds sample

For each bond, we split trades across trade size categories. These categories are the same for Euro and for Sterling denominated bonds. For the latter, amounts are converted into Euros, using the exchange rate prevailing at the time of the trade. We then computed the effective quoted spread for each bond, in each trade size category. Finally we computed the average across bond of the effective spread, for each trade size category.

	2003	**2004**	**2005**
Euros			
€ [0 - 10.000]	0.218%	0.100%	0.104%
€]10.000 - 25.000]	0.204%	0.109%	0.119%
€]25.000 - 50.000]	0.216%	0.089%	0.108%
€]50.000 - 100.000]	0.184%	0.095%	0.100%
€]100.000 - 200.000]	0.194%	0.079%	0.113%
€]200.000 - 500.000]	0.154%	0.059%	0.109%
€]500.000 - 1.000.000]	0.127%	0.058%	0.103%
€]1.000.000 -]	0.118%	0.057%	0.082%
Sterling			
€ [0 - 10.000]	0.611%	0.340%	0.287%
€]10.000 - 25.000]	0.515%	0.330%	0.272%
€]25.000 - 50.000]	0.405%	0.225%	0.230%
€]50.000 - 100.000]	0.431%	0.234%	0.203%
€]100.000 - 200.000]	0.371%	0.209%	0.210%
€]200.000 - 500.000]	0.391%	0.168%	0.175%
€]500.000 - 1.000.000]	0.416%	0.164%	0.148%
€]1.000.000 -]	0.349%	0.163%	0.170%

Table VII

Effective spreads by trade size in 2003 for BBB bonds

For 2003, we considered BBB European bonds. We converted trade size and issue size into dollars, using the exchange rate from January 2, 2003. We selected the bonds with issue size between $10,000,000 and $1,000,000,000. This left us with 51 Euro denominated bonds and 85 Sterling denominated bonds. For each bond, we split trades across trade size categories. We then computed the effective quoted spread for each bond, in each trade size category. Finally we computed the average across bond of the effective spread, for each trade size category. For the sake of comparison, the table also reports the effective spreads estimated by Goldstein, Hotchkiss and Sirri for BBB bonds, with issue size below 1,000,000,000, relying on data from 2003.

	European Sample Bonds denominated in:		TRACE sample Transparent bonds Goldstein, Hotchkiss & Sirri (2007)
	Euro	Sterling	
< $10,000	0.40	0.75	2.74
[$10,000 ; $20,000]	0.29	0.64	2.34
($20,000 ; $50,000]	0.32	0.62	1.88
($50,000 ; $100,000]	0.27	0.70	.66
($100,000 ; $250,000]	0.25	0.52	.35
($250,000 ; $1,000,000]	0.16	0.42	.37
> $1,000,000	0.13	0.44	.27

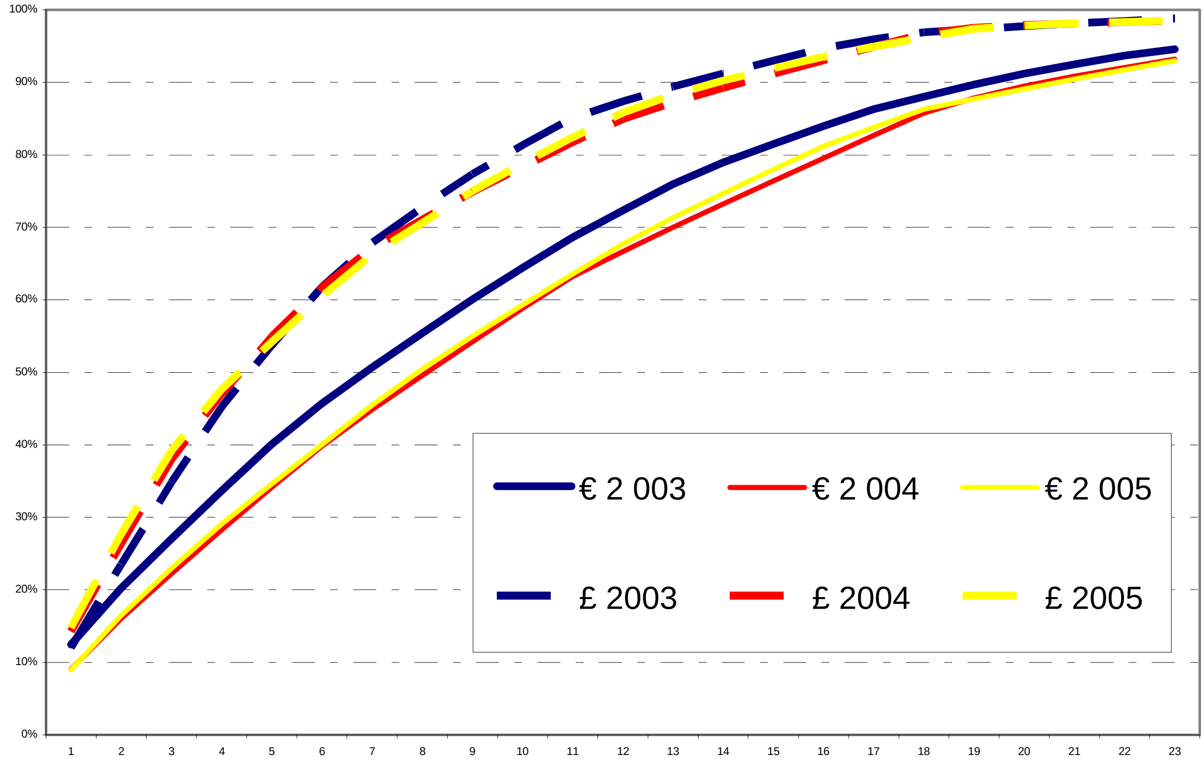


Figure 1: Market share of the dealers. This figure depicts the market share of the N most active dealers in a bond. The horizontal axis is the number of dealers. N. The vertical axis is the market share (in terms of number of trades) of these N dealers.

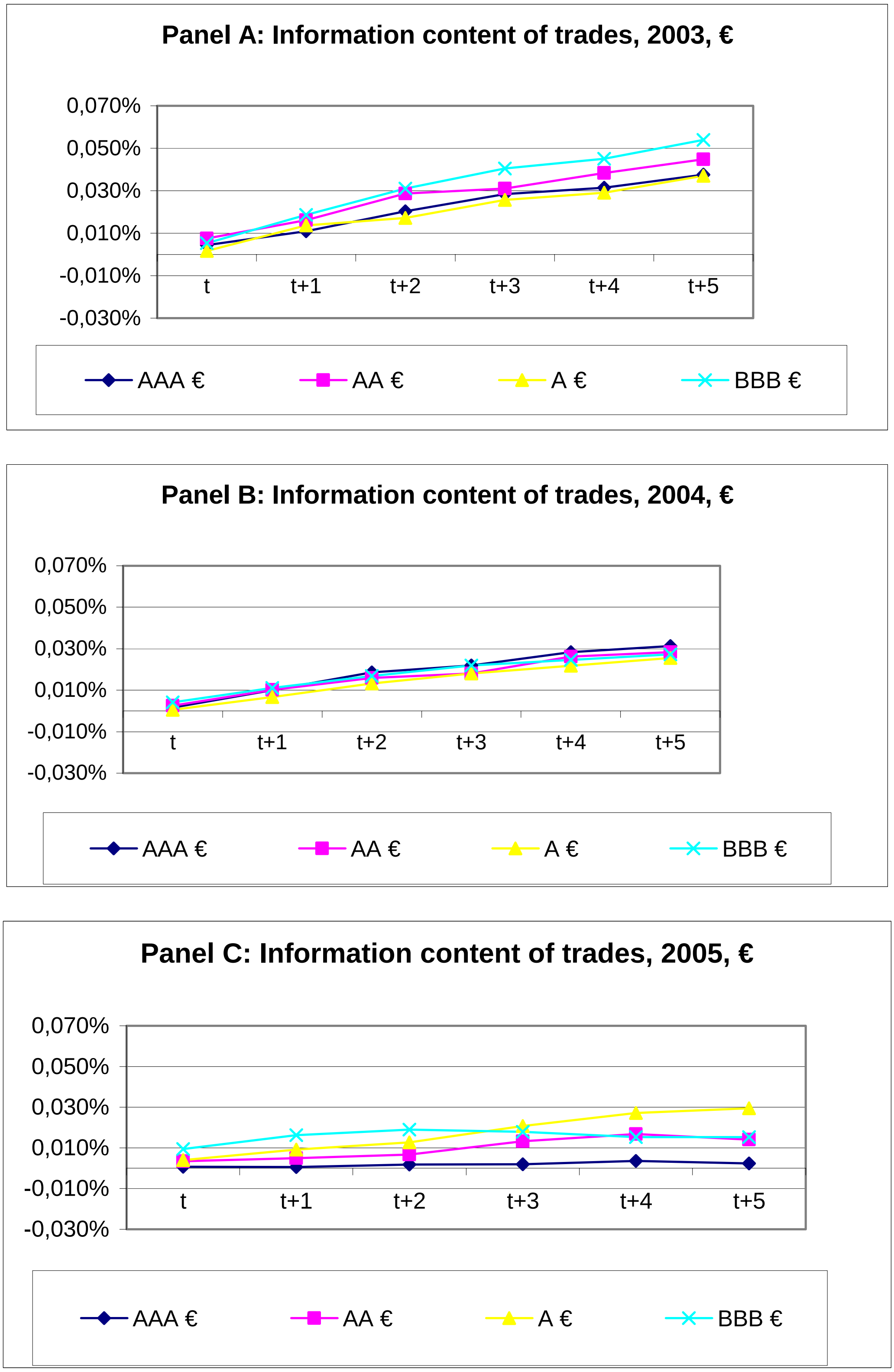
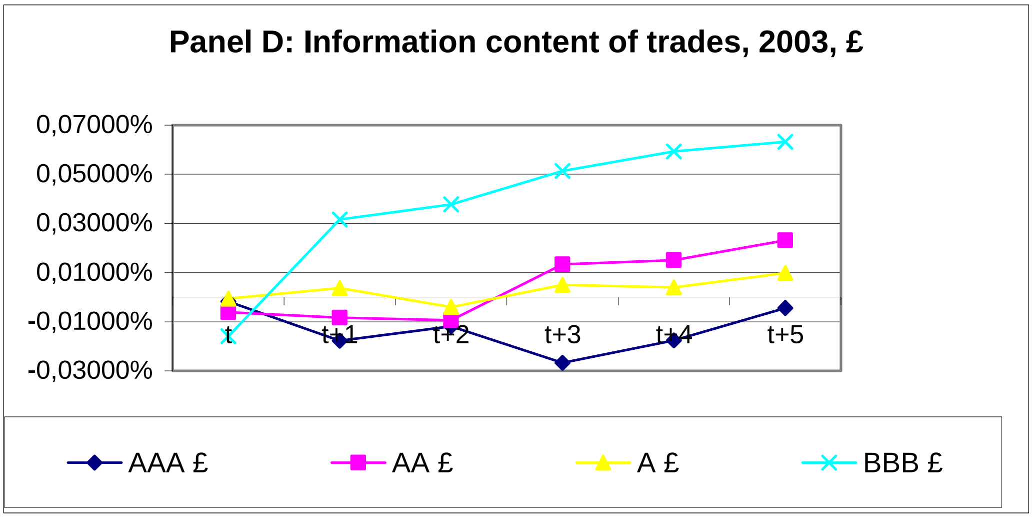
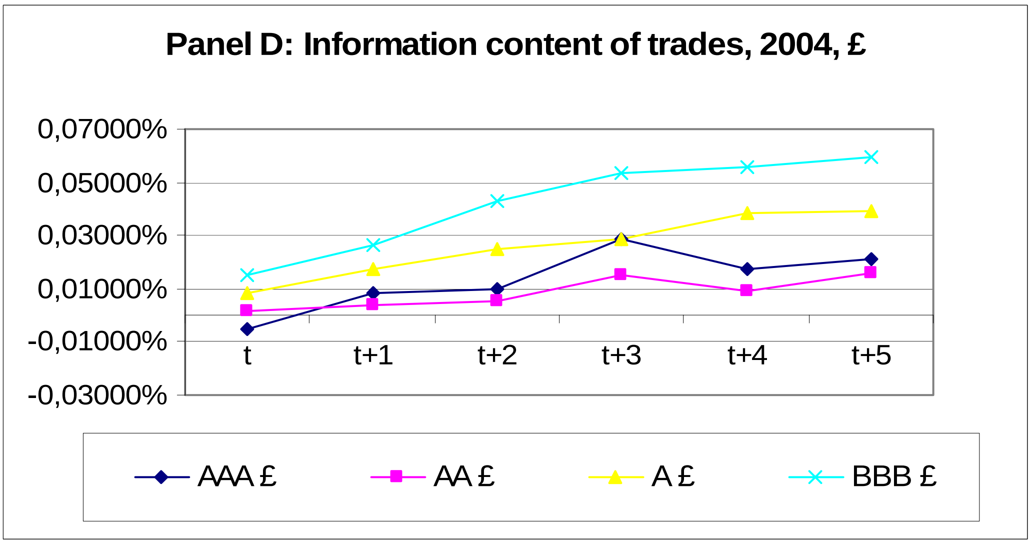


Figure 2: Information content of trades. This figure depicts the average across bonds of the time-series average increase (resp. decrease) in midquote after a purchase (resp. sale). For a trade occurring on day t, the figure plots the percentage change in midquote from day t-1 to day t+i, i=0.1.2.3.4.5.





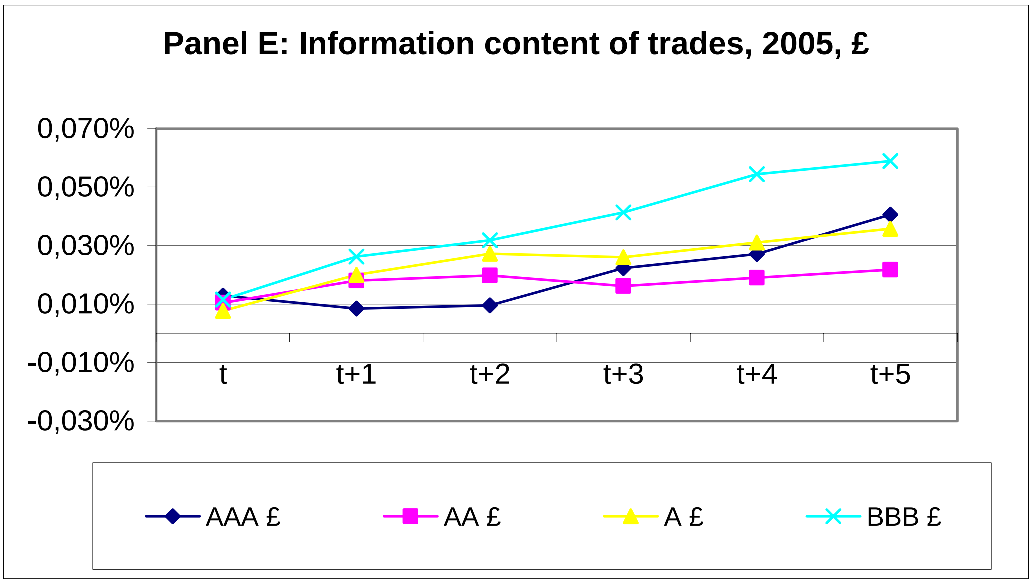


Figure 2: Information content of trades (Contd.)

Appendix: The MarketAxess Electronic Bond Trading Platform

The customers of MarketAxess are institutional investors. In this market €200.000 would be a small size and €1.000.000 a typical size. The platform facilitates trading in approximately 5000 bonds in Europe with about 250 trades a day. MarketAxess was developed as a computerized equivalent to the traditional telephone based system. Just like the telephone system it involves customers announcing their desired size and direction and asking dealers for quotes. Clients can request quotes from up to 6 dealers. Like on the telephone, the identity of the customer is revealed to the dealers. Consistent with models of repeated interaction, different customers might well get different prices for the same trade. The dealers contacted by the customer have 3 minutes to post prices, which remain firm for a small amount of time. The customer can take one of these offers by clicking on it. Thus, bond trading on MarketAxess works as a sequence of computerized first price auctions. This system enhances the efficiency of the market for the investors in two ways: First, it displays information on which dealers are interested in trading which bonds. This simplifies a lot the search problem of the investor. Second, by running an auction for the customers MarketAxess enhances their ability to let dealers compete with one another.

Notes

[i] Green, Hollifield and Shurhoff (2007) and Harris and Piwowar (2004) also offer very informative studies of the microstructure of the municipal bond market, which shares many features of the corporate bond market, such as OTC trading and dispersion of liquidity across many securities.

[ii] Chakravarty and Sarkar (2003) studies institutional trades in corporate bonds over 1995-1997. They find an average bid-ask spread of the order of magnitude of 20 cents for a nominal bond price of $100. Edwards, Harris and Piwowar (2007) estimate that, for a retail order size of $ 20,000, the bid-ask spread is 138 cents. For trades of $ 200,000 their estimate of the average spread falls to 54 cents.

[iii] At the July 2002 start of TRACE, post trade information was publicly disseminated for very large and high-quality issues. For the other bonds, post-trade transparency was phased in later.

[iv] This is likely to be one of the reasons underlying the remarkable development of the Credit Derivative Swaps market. Sellers of such swaps receive the yield spread as long as the issuer of the bond services its debt. They pay the buyers of the swap when the firm defaults. While, until recently, insurance companies, pension funds or UCITs generally could not trade CDS, dealers could. This facilitated their ability to trade risk and increased their risk management ability.

[v] Retail investors or small institutional investors do not contact dealers directly. They trade through the intermediation of their bank or of brokers.

[vi] ICMA defines itself as “the self-regulatory organisation and trade association representing the investment banks and securities firms issuing, trading and dealing in the international capital markets worldwide.” (See its website http://www.icma-group.org.)

[vii] IIC first checks whether the quotes are non negative, whether the bid is lower than the ask quote, and whether the spread is blow 500 bp. To be included in the average, the quotes must pass these tests. Second, IIC checks if the difference between the maximum bid quote and the minimum bid quote is below a threshold. If it is not quotes are inspected further and outliers are eliminated. The same filter is applied on the ask side.

[viii] This suggests that the quotes supplied by IIC, are meaningful prices.

[ix] To illustrate, for a Euro denominated bond valued at €100, buyers would on average pay €100 and 5 cents to the dealers. And customers buying a bond valued at £100 would typically purchase it from dealers at £100 and 10 pence.

[x] This is the economic intuition underlying the theoretical corporate finance literature showing that debt contracts optimally mitigate adverse selection problems, see, e.g., Myers and Majluf (1984), DeMarzo and Duffie (1999) and Biais and Mariotti (2005).