

Liquidity & Price Discovery in the European Corporate Bond Market

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Abstract:

Using a new quotes and trades dataset, provided to us by the International Index Company (IIC) and the International Capital Market Association (ICMA), we analyse transactions costs and information in the European corporate bond market in 2003, 2004 and 2005. In line with theoretical models, spreads increase with maturity and default risk. They also decrease with trade size, as found by previous studies for the US market. Euro-denominated bonds have tighter spreads than Sterling-denominated bonds. Their liquidity compares favourably to that of their post-TRACE US counterparts. This is consistent with the presence of a large pool of potential buyers and sellers in the unified Euro market, attracting rather competitive dealer liquidity. In line with asymmetric information theories, trades have significant information content, especially for bonds with low ratings. It takes more than one day for the information content of a trade to be fully impounded in market pricing. This could stem from limited post trade transparency.

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I) Introduction

Bonds play a very important role in the financing of our economies. As can be seen in Figure 1, the size of the bond market is very large. In the US its capitalization is roughly the same as that of the stock market. In Europe the former is even larger than the latter. It should be noted, however, that the relative weights of different types of bonds differ across countries. In Europe, government bonds and those issued by financial firms amount to a much larger fraction of the market than in the US.

Several empirical studies offer interesting evidence about the government bond market (see e.g. Fleming & Remolona, 1999). The corporate bond market is markedly different from the Treasury market, however. The latter involves one powerful issuer, repeatedly tapping the market, for large and rather standardized issues. The former involve a large number of diverse issuers, some rather small, infrequently tapping the market, for rather small quantities, often quite non-standard. Hence the corporate bond market is naturally less liquid than the Treasury market.

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. Is the supply of liquidity competitive? Does it result in satisfactory liquidity? Does the market convey adequate information to economic agents? These are important issues, as the liquidity and informational efficiency of the bond market directly affect the cost of funds for issuing firms and the investment opportunities of household.ⁱ

While the microstructure of equity markets has been extensively studied, we have much less knowledge of liquidity and trading costs in the corporate bond market.ⁱⁱ Recently, however, several empirical studies have shed interesting light on the microstructure of the US corporate bond market. Their estimates of the bid-ask spread tend to be larger than estimates obtained

from the stock market.ⁱⁱⁱ This is surprising, since bonds are less risky than stocks, and spreads increase with risk. This suggests that other factors, related to specific features of bond market, such as its microstructure or the ownership of bonds, may be at play.

One of these factors could be the transparency of the market. In the US, in 2002, regulation TRACE imposed post-trade transparency.^{iv} Edwards, Harris and Piwowar (2004) estimate that this increase in transparency reduced the bid-ask spread by about 5 to 10 cents (for a nominal bond price of \$100.) Goldstein, Hotchkiss and Sirri (2005) 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 (2005) find that, even for institutional trades, TRACE reduced spreads.

In contrast with the US bond market, we have very little evidence on the microstructure and liquidity of the European bond market. Such evidence would be valuable, however.

First, it would provide a useful out of sample robustness check of the results obtained for the US market. Are the rather surprising features of that market also observed in Europe: Do we see relatively large spreads? Are effective spreads increasing in trade size?

Second, the European corporate bond market is not post-trade transparent, as it has not undergone a regulatory reform comparable to TRACE. Hence, comparing liquidity and transactions costs in the corporate bond market on both sides of the Atlantic can help one understand better the consequences of post-trade transparency. Does greater opacity in the European market lead to larger spreads than in the US market? Do other factors drive the relative size of spreads on both sides of the Atlantic?

An additional interesting feature of the European market is that it includes two different segments: the Eurozone, which is composed of several countries and attracts many investors and liquidity suppliers, and the Sterling zone, for which the potential number of participants is smaller. International investors tend to operate in Euro denominated bonds rather than in Sterling bonds. Most investors in Sterling are UK institutions: insurance companies, pension funds or UCITs. The investors in this relatively small pool of participants tend to follow buy and hold strategies. This situation is likely to generate relatively low liquidity. Does this affect bid-ask spreads, trading activity, dealer participation?

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). The data include trades and quotes for 627 €denominated bonds in 2003, 765 in 2004 and 812 in 2005. For £ denominated bonds, the number of bonds in our dataset is 539 in 2003, 653 in 2004 and 647 in 2005. This sample is quite representative of the universe of investment grade corporate bonds in Europe. For these bonds, over the three years, our dataset includes a complete report of 1,952,244 time-stamped trades, with the transaction's price, the volume, and the characteristics of the bond. This unique data-set enables us to propose the first high-frequency data analysis of the microstructure of the European corporate bond market.

Our main results can be summarized as follows:

Trading activity: The average number of trades per bond and per day is slightly above 3 for €denominated bonds and 2 for £ denominated bonds. For €denominated bonds the average transaction size is around one million euros. For £ denominated bonds it is around £ 800,000. Trading activity is relatively stable throughout our sample years.

Maturity, ratings and transaction size: In line with theoretical models, spreads increase with maturity and default risk. This was also found for the US bond market, which suggests the economics of the secondary markets for bonds are not radically different in Europe and in the US. They also decrease with trade size, which is similar to the results obtained by previous studies for the US market (Edwards, Harris and Piwowar (2004) and Goldstein, Hotchkiss and Sirri (2005).) Note that such a decrease was also observed in dealer operated equity markets such as Nasdaq (see Christie and Schultz, 1994) and the London Stock Exchange (see Reiss and Werner). Hence, it is likely to be a structural feature of dealer market. We also find that spreads were much higher in 2003 than in 2004 and 2005. This is because, in 2003, the market perceived default risk to be quite high, and large risk leads to wide spreads.

€versus £ denominated bonds: For €denominated bonds, we find that spreads are rather tight. In 2005, for a bond valued at €100, the ask price would be on average at € 100.05 and the bid at €99.95. In 2003, the corresponding figures are 100.07 for the ask and 99.93 for the bid. For Sterling bonds, the spread is less tight. For a bond valued at £ 100, in 2005, the ask price would typically be at €100.10 and the bid at €99.90.

As discussed above, 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. Consistently with this interpretation, we find that the Sterling market has both larger spreads

and more concentration of dealership activities than the Euro denominated market. In the former, the market share of the three most active dealers in a given bond is typically above 50%. In the latter, it is below 40%.

Spreads in the Eurozone and in the US: Our estimates of the effective spreads for € denominated bonds are lower than their US counterparts. In their sample of 90 BBB bonds, Goldstein et al (20005) find that, for transaction sizes, above one million, the half-spread is .22% before dissemination and .135% after.^v In our sample, for the same period (2003), the effective half spread for trades above one million euros is .049%. For BBB bonds, in 2003, we find an average effective spread of .095%. Hence, controlling for sample period and credit risk, we find that effective spreads in €denominated bonds are lower than their post-trade transparent US counterparts.

Since the advent of the Euro, the European bond market is quite integrated. Investors from all European countries trade in the same market. This large pool of buyers attracts sell-side intermediation. And banks from one country of the Eurozone can easily deal with investors from another country of that zone. Our results suggest that, as a result, the supply of liquidity in the €denominated bond market is rather competitive, which drives spreads down.

Information content of trades: In line with asymmetric information theories, trades are found to have significant informational content, especially for low rating bonds. It takes more than one day, however, for the information content of a trade to be fully impounded in market pricing. Such a delay likely stems from the lack of post trade transparency.

The next section describes the workings of the European Corporate Bond Market. Section III presents our dataset. Section IV presents our empirical results. Section V concludes and discusses policy implications of our analysis.

II) Institutional Setting

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) attract a specific type of investors: Pension funds and insurance companies are among the largest investors in

bonds. These investors, especially insurance companies, tend to follow buy and hold strategies. This limits the level of activity in the secondary market. Indeed, certain issues are entirely purchased by a single buy-and-hold investor. All this severely reduces the liquidity of the 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 practically impossible to sell it.^{vi}

Third, while stocks are very specific, and differ from one another, differences between bonds are less marked. Often investor will desire to trade a certain category of bond (say utility, 10 years to maturity, A-rated) rather than a given bond. In that case, when contacting potential counterparties investors will not only ask for a quote, they will also which bond is for trade at the moment. Note that this way of arranging trades to some extent mitigates the inefficiencies brought about by the difficulty of short sales.

Fourth, 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 much 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 will be a much more difficult task to identify a counterpart than in the stock market.

Dealership

The European corporate bond market, like its US counterpart, 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 on the interdealer market.

Alternatively, the investor can contact a broker, who will direct the agents to interested counterparties. Also, the sequencing of the games 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 they will reflect the costs of market making, and also possibly the rents of the dealers. In contrast with the convention used in several other markets, brokers in the European corporate bond market are not explicitly rewarded by commissions. In the trades they arrange, they receive the bid-ask spread between the price paid by the buyer and the price received by the buyer.

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 good private information about which bonds are relatively easier to trade at a given point in time, and about who is interested in trading them.

Telephones and screens

Traditionally, interaction in the bond market has been taking place on the telephone. Institutional investors would call dealers on the phone, negotiate on the price, and then have the option to call another dealer.^{vii} Or the customer would call a phone broker, who would simultaneously call several dealers. Of course, this technology limits the number of dealers the customer can contact. This increases the search costs incurred by the customer, when searching for the right counterpart or the right bond. This limits the ability of the customer 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.

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 quotes are indicative, but close to the prices at which trades can occur. Bonds, however, 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 recent or significant quotes on Bloomberg screens.

Electronic trading platforms

Recently, electronic trading platforms have developed. They can be put in place by a single dealer, offering its customer pricing information. They can also involve several dealers. One of the most successful platforms in the European corporate bond market is MarketAxess. This platform relies on 20 dealers and attracted 360 clients. These customers are large institutional investors (in this market €200,000 would be a small size, and €1,000,000 a typical size). MarketAxess facilitates trading in approximately 5000 bonds in Europe. There are about 250 trades a day on this platform.

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.

Regulation

Since it is a dealer market, the European bond market is decentralized. This market is self regulated by the International Capital Market Association (ICMA).^{viii} 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 AMF in France and the London Stock Exchange.

All the London based members of ICMA (i.e., the huge majority of the dealers in the European Corporate Bond market) and all members of the Council of reporting Dealers, irrespective of their location, have to report their trades to this self regulatory organisation, through a system known as TRAX. TRAX captures most of the 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.

Transparency

Currently, there is no systematic post-trade transparency in the European corporate bond market. For large investors, there is a significant amount of pre-trade transparency. As discussed above, institutions can obtain competing firm quotes from dealers through electronic trading platforms or brokers. In addition, information on quotes is disseminated by data vendors and via Bloomberg messaging. For retail investors and small institutions, in contrast, it is likely that there is little transparency in the bond market, be it pre- or post- trade.

An interesting and important example of electronic quote dissemination in the bond market is offered by the International Index Company (IIC), which computes and disseminates iBoxx indices. In this paper, we focus only on the corporate bond market segment of their activity. iBoxx indices are computed for hundreds of Euro-denominated bonds, and hundreds of Sterling 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.^{ix} 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, at least 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. Because the IIC bond prices are reliable, they can be used by investors as a benchmark when negotiating trades with dealers, or to value their portfolios.

To ensure that the bonds in the index are roughly comparable, iBoxx includes only plain vanilla bonds, excluding sinking funds and callable bonds. Furthermore, to ensure that there will be a minimum amount of liquidity bonds can be included in the iBoxx universe only if their amount outstanding is at least €500 million. Finally, the bonds included in the iBoxx index are investment grade, i.e., their ratings range from AAA to BBB.

Pricing conventions

Market practitioners use several alternative conventions to express bond valuations. Sometimes, they express those values in terms of prices, for a nominal of €100. Alternatively they express the value of the bonds in terms of yield to maturity, or in terms of the difference between the yield of the bond and a benchmark yield, on a government bond. Of course, there is a one to one mapping between prices and yields. Platform organizers (such as e.g., MarketAxess) or data vendors (such as, e.g., Bloomberg) provide conversion engines. Denote the bond value at time t by V_t , and its maturity by T . Denote the sequence of cash flows it promises by F_τ . The yield to maturity is y_t such that:

$$V_t = \sum_{\tau=t+1}^T \exp[-y_t(\tau-t)] F_\tau = V(y_t).$$

In an imperfect market, the fundamental value is not directly observed, only ask and bid and transactions prices are observed. Assuming the bid and ask prices (A_t and B_t) are symmetric around the value of the bond, and denoting by S_t the proportional spread we have:

$$A_t = V_t(I+S_t/2), \quad B_t = V_t(I-S_t/2), \quad (1)$$

while the absolute spread is: $A_t - B_t = V_t S_t$ and the midquote is: $(A_t + B_t)/2 = V_t$. Similarly, denote the ask and bid yields by: $y_{t-s_t/2}$ and $y_{t+s_t/2}$. We have:

$$\begin{aligned} A_t &= V(y_{t-s_t/2}) = V(y_t) - s_t/2 V'(y_t) + o(s_t) \\ B_t &= V(y_{t+s_t/2}) = V(y_t) + s_t/2 V'(y_t) + o(s_t) \\ (A_t - B_t) &= (-V'(y_t)) s_t + o(s_t). \end{aligned} \quad (2)$$

Together (1) and (2) imply that the bid ask spread in terms of yields is approximately equal to the price spread divided by the duration (D_t):

$$S_t / D_t = s_t + o(s_t). \quad (3)$$

III) Data

III.1) Datasets

Quote data

The International Index Company (IIC) gave us the history of daily, end of day, bid and ask quotes for the € and £ denominated bonds in its iBoxx index. These bonds represent the vast majority of the European investment grade, plain vanilla bond market. For 2003 and 2004, we consider the subset of these bonds which were already issued and which did not mature before 2005. We discarded from this subset the bonds for which quotes were missing for more than 15% of the days (missing data was mostly concentrated in 2003.) We also discarded two Sterling denominated bonds, with erratic behaviour. These two bonds - AAA rated and with 30 years maturity - were issued during our sample period. There were two sharp and large increases in their spreads 30 days and 50 days after their issuance. As reported in Table 1, this leaves us, for € denominated bonds, with 627 bonds in 2003, 765 in 2004 and 812 in 2005. For £ denominated bonds, the number of bonds in our dataset is 539 in 2003, 653 in 2004 and 647 in 2005.

The bid and ask quotes are expressed with the convention of a nominal bond price of €100 or £ 100, except in the case of zero-coupons. 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.

Transactions data

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.

As reported in Table 1, for €denominated bonds we have transactions data for 637 bonds in 2005, 594 in 2004 and 310 in 2003. For £ denominated bonds, the corresponding figures are 543 bonds in 2005, 511 in 2004 and 336 in 2003. Overall, we have 1180 bonds in 2005, 1105 in 2004, and 646 in 2003. While this is a large number of securities, this is much lower than in the samples analysed by Edwards, Harris and Piwowar (2005) and Goldstein, Hotchkiss and Sirri (2005), which included 16,746 and 5,503 bonds, respectively.

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., the trades with value traded below 100 (€or £), and the trades with value traded above 20 millions (€or £). We also eliminated 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 1,952,244 transactions. This includes the inter-dealer trades, but excludes double counting. When two dealers trade and each report the trade to ICMA, this shows up in our data as a single transaction.

One major difference between our dataset and those used by Edwards, Harris and Piwowar (2005) and Goldstein, Hotchkiss and Sirri (2005) relates to trade size. In the US studies, in terms of number of trades, the majority of the observations are retail trades. In our data, there

are practically no retail size trades, since those are generally not reported to ICMA. Another major difference relates to the time period. Edwards et al (2005) and Goldstein et al (2005) studied the immediate aftermath of TRACE. For example, Goldstein et al (2005) analyze data from July 2002 to February 2004. In contrast, we study data from 2003, 2004 and 2005.

III.2) Structure of the sample

Issue size

As mentioned above, our sample includes only plain vanilla bonds - excluding sinking funds and callable bonds – with amount outstanding greater than or equal to €500 million. This differs somewhat from the sample analyzed by Goldstein, Hotchkiss and Sirri (2005) who consider bonds with issue size between \$10 million and \$1 billion. In terms of issue size our sample also differs from that analyzed by Edwards, Harris and Piwowar (2005). Half the bonds in their sample fall in what they call the medium (\$100 million - \$5000 million) issue size category. Our current dataset does not include information on issue sizes. We are currently working on collecting that information.

Industry

The industry structure of our sample of bonds with trades and quotes is given in Table 2. For both currencies the most frequent industry is financials, and the weight of these bonds in our sample is very stable through years (ranging between 45% and 46% for € and between 56% and 60% for £). This is in line with the stylized fact that the fraction of corporate bonds issued by financial firms is quite large in Europe. It is similar to the US sample of BBB bonds studied by Goldstein, Hotchkiss and Sirri (2005) where financials account for 44% of the bonds. Also in both currencies, utilities represent a sizeable and stable fraction of the sample (ranging from 10% to 13% for € and from 11% to 13% for £.) In comparison, in the US sample studied by Goldstein, Hotchkiss and Sirri (2005) around 20% of the bonds are issued by utilities. Another sizeable fraction of the sample, for Euro or Sterling denominated bonds, is consumer services or goods. Also, for € telecommunications range between 9% and 13% of the sample – a legacy from the bubble period. This differs from the sample of Sterling denominated bonds, or the US sample.

Maturity and rating

The structure of our samples in terms of maturity and rating is depicted in Figure 2. For both currencies, A-rated bonds are by far the most frequent, and this is quite stable across years in our sample. The next frequent rating is BBB, again for both currencies and across sample years. AA bonds come next. The least frequent bonds are AAA. Their frequency is slightly higher in the £ sample than in the €sample. This differs, by construction from the sample of BBB US bonds analysed by Goldstein, Hotchkiss and Sirri (2005). It also differs from the sample of bonds analysed by Edwards, Harris and Piwowar (2005), in which AAA bonds included 9% of the population, and speculative grade bonds (with ratings lower than BBB) included 23% of the population.

Table 3 offers additional information on the maturity structure of the bonds in our sample. For Euro denominated bonds, the most frequent maturities are 2, 3, 4, 5 and 6 years, as well as ten years. Ignoring the 11 bonds with maturity longer than 20 years, the average maturity for Euro denominated bonds in the IIC sample is 6 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 the Euro denominated bonds. Ignoring the 59 bonds with maturity longer than 20 years, the average maturity for Sterling denominated bonds in the IIC sample is 9 years. These maturities are comparable to those of the US corporate bonds studied by Goldstein, Hotchkiss and Sirri (2005), which have an average maturity of 7.8 years.

Conclusion

Overall, these statistics suggest that our sample is relatively broad and quite representative of European investment grade bonds. Also, the maturity, industry and rating structure of our sample is fairly stable across years. While our sample includes a smaller number of bonds, it is not markedly different, in terms of maturities and industries from the US samples studied by Goldstein, Hotchkiss and Sirri (2005) and Edwards, Harris and Piwowar (2005). In terms of ratings it does differ somewhat from the US samples, since that studied by Goldstein, Hotchkiss and Sirri (2005) includes only BBB bonds, while that studied by Edwards, Harris and Piwowar (2005) includes relatively more AAA and speculative grade bonds than ours. Also, our sample only includes plain vanilla bonds, like the sample of Goldstein, Hotchkiss

and Sirri (2005), while that of Edwards, Harris and Piwowar (2005) includes bonds with complex features (callable, convertible, sinking, etc...).

IV) Empirical Results

IV.1) Trading activity

In this subsection we report findings on the number of trades and the size of trades, from the TRAX dataset, in 2004 and 2005.

Daily number of trades

For each bond in the TRAX sample, using data from 2004 and 2005, we computed the average number of trades per day. The median, across the Euro-denominated bonds, of these daily averages is 3.37 in 2003, 3.56 in 2004 and 3.07 in 2005. Across the 545 Sterling denominated bonds, the median average daily number of trades is 2.07 in 2003, 2.51 in 2004, and 2.23 in 2005. The minimum (across bonds) of the average daily number of trades is slightly larger than one for both currencies. The maximum average daily number of trades is above 50 for Euro denominated bonds and varies between 10 and 33 for Sterling bonds.

Figure 3 depicts the average daily number of trades for bonds with different ratings. The relation between the average daily number of trades and the rating of the bond is U shaped, for both currencies. AAA rated bonds and BBB rated bonds are the most frequently traded, while AA and A are somewhat less frequently traded. This could reflect the interaction of two countervailing effects. On the one hand, high rating can increase liquidity by reducing adverse selection. On the other hand, news affecting the values of higher risk bonds are relatively more frequent, thus generating relatively greater activity. Finally note that for both currencies and all ratings, there are no clear differences across years in terms of average number of bonds traded.

As mentioned in the introduction, the Euro denominated bonds market attracts many investors, from the Eurozone and from other regions. In contrast, most investors in Sterling bonds are UK institutions (insurance companies, pension funds or UCITs) which tend to

follow buy and hold strategies. Our empirical results show that, correspondingly, trading is more active in the Euro denominated market than in the Sterling denominated market.

The European bonds in our sample are more frequently traded than the US corporate bonds analysed by Goldstein, Hotchkiss and Sirri (2005) and Edwards, Harris and Piwowar (2005). Goldstein, Hotchkiss and Sirri (2005), focusing on BBB bonds, find an average number of trades per day equal to 1.1, which is lower than the medians in our sample for BBB bonds in 2003: 4.12 for Euros and 2.51 for Sterlings. Edwards, Harris and Piwowar (2005), 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 (2005) and Goldstein, Hotchkiss and Sirri (2005) 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 based studies.

Table 4 shows how the average daily number of trades varies with maturity. For Euro denominated bonds, the relationship between trading activity and maturity tends to be U-shaped. Bonds with only short maturity, as well as long term bonds are most actively traded. Bonds with intermediary maturities are less actively traded. For Sterling denominated bonds, there is no strong pattern, although bonds with 5 or 10 years to maturity tend to be more active. The link between maturity and activity may reflect some clientele effects. Some market participants are constrained to hold bonds with a given maturity, such as ten years for example. Other participants choose to hold bonds with a given maturity because of the structure of their own balance sheet. For example, life insurance companies may find it optimal to tilt their portfolios towards long bonds. These biases in the term structure of portfolios will impact the maturity structure of the trading activity in the bond market. It is possible that different clientele effects lead to different patterns of trading activity for Euro and Sterling denominated bonds.

Trade size

For each bond in our TRAX sample, we computed the average of all trade sizes. Then we studied the distribution of this average across bonds. The results are in Table 5. Average trade sizes are quite large, typically around €1,000,000 or £ 800,000. This is larger than their counterparts in the TRACE based US studies of Edwards, Harris and Piwowar (2005) and

Goldstein, Hotchkiss and Sirri (2005). This reflects the fact that our TRAX dataset does not include the small trades, as mentioned above. Average trade sizes are somewhat larger in the Sterling denominated bond market than in the Euro denominated one. Also, trade sizes tend to increase with default risk. This suggests that more difficult trades, in riskier bonds, tend to be lumpier.

Average total trading volume per bond

While trading frequency is greater for Euro denominated bonds, the size of individual trades is lower. Which of the two effects dominate when it comes to total trading volume? To answer this question we computed the average total trading volume per day for Euro denominated bonds and also for Sterling denominated bonds. Then we divided each of these averages by the number of bonds in our sample for each of the two currencies. The results are in Table 6. We find that, for Euro denominated bonds, the average trading volume per day and per bond is typically between €3,500,000 and 4,200,00. The corresponding figures for Sterling denominated bonds are around: £ 700,000 and 1,000,000. Converted at the exchange rate that prevailed on November 13, 2005 (1.4857), this corresponds to an average daily trading volume per Sterling denominated bond ranging between €1,000,000 and 1,500,000. We checked that the ranking of the two currencies in terms of volume per bond is the same for all ratings and all maturities. Thus, overall trading activity is lower in the Sterling denominated market.

IV.2) Quoted spreads

In this subsection we report findings on the quoted spread, from 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:

$$M_{i,t} = (A_{i,t} + B_{i,t})/2, \quad (4)$$

and the (proportional) quoted spread is:

$$S_{i,t} = (A_{i,t} - B_{i,t})/M_{i,t}. \quad (5)$$

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. Then we studied the distribution of this average across bonds.

Findings

Figure 4 presents the average quoted spread, in each currency, by rating. For both currencies, average quoted spreads decrease from 2003 to 2004. Most of the decline occurs between 2003 and 2004.

The figure shows that quoted spreads are much tighter for €bonds than for £ ones. This holds for all ratings and all sample years. The difference can be economically very significant. For example, in 2005, for AAA bonds, the average quoted spread is .13% for €bonds and .36% for £ bonds.

For £ bonds, average quoted spreads increase monotonically as ratings decline. This is not the case for €bonds. For these bonds, while spreads are very tight for AAA ratings, they are roughly the same for AA, A and BBB ratings.

Figure 5 presents the average quoted spread, in each currency, by maturity, measured as the number of years from the sample date to the redemption of the bond. For both currencies, and all sample years, average quoted spreads tend to increase with maturity, but this is more pronounced for £ than for €bonds. €denominated bonds have smaller average quoted spreads than £ bonds, for all maturities between 3.5 and 17.5 years, and this ranking is stable across sample years. For the shortest maturities (below 3.5 years) however, the ranking between the two currencies is unclear.

Discussion

Determinants of spreads: The results in Figure 4 and Figure 5 suggest that spreads in the European corporate bond market vary with economic forces, as suggested by theoretical reasoning. 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 duration of the bond (which can be proxied by its maturity) and its credit risk (which can be proxied by its rating). Consistently with these implications of the theory, we find that bid-ask spreads in the European corporate bond market increase with maturity and decrease with credit quality.

This finding suggests that the bid and ask quotes supplied by IIC, are meaningful prices, and also that market pricing varies in line with costs, and thus is not completely dominated by market power. This contrasts, for example, with the findings of Chen and Ritter (2000) for underwriter spreads in the equity IPO market. There, spreads were found to be constant, independent of variations in economic variables determining intermediation costs. This was interpreted as suggesting that spreads reflected collusion rather than marginal costs.

Comparison between the Euro and Sterling markets: Except for the shortest maturities, average quoted spreads are tighter for €denominated bonds than for £ bonds. That this result obtains for most maturities and all ratings implies that the overall difference between €and £ spreads is not driven by differences between the two subsamples in terms of maturity or rating. This finding (based on our IIC quote data) is in line with the previous one (based on our TRAX transactions data) that trading activity is greater for Euro denominated bonds. Both reflect that the Euro denominated market is larger and more liquid than its Sterling counterpart. There are more potential investors in the former than the latter. This increases trading frequency, and correspondingly trading business. This attracts dealership services. It also enhances the ability of dealers to turn around their positions. Both phenomena reduce spreads.

IV.3) Effective spreads

In this subsection we report findings on effective spreads, based on the merged quote dataset (IIC) and trades dataset (TRAX).

Method

Consider bond i on day t . Focus on the cases where there is at least one trade during the day. Consider the n^{th} transaction reported for bond i on day t in the TRAX dataset. Denote the transaction price by: $P_{i,n,t}$, the trade size by $X_{i,n,t}$ and the direction of the trade by: $Z_{i,n,t}$ (the latter 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 expected 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:

$$V_{i,n,t} = E[v_i | H_{i,n,t}],$$

where $H_{i,n,t}$ is the information set of the market just before the trade. The effective half-spread for this transaction is:

$$Z_{i,n,t} (P_{i,n,t} - V_{i,n,t}). \quad (6)$$

This is difficult to measure, however, since the fundamental value is not observable. To cope with this problem, we use the midquote as a proxy for the value. Specifically, we assume that:

$$M_{i,t-1} = E[v_i | H_{t-1}] = E(V_{i,n,t} | H_{t-1}), \quad (7)$$

where H_{t-1} is the information set of the market at the end of day $t-1$. Hence,

$$V_{i,n,t} = M_{i,t-1} + \varepsilon_{i,n,t},$$

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 ($E(\varepsilon_{i,n,t} | H_{t-1})=0$.) Hence, the effective half-spread can be written as follows:

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

Note that:

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

Thus, denoting by EA the empirical average, we have that:

$$EA[Z_{i,n,t} (P_{i,n,t} - M_{i,t-1})] \quad (8)$$

is an unbiased estimator of the effective half-spread. Note that, to compute this estimate we use both data from TRAX ($Z_{i,n,t}$ and $P_{i,n,t}$) and data from IIC (to compute $M_{i,t-1}$.)

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 day midquote.

Results

Estimates of the effective half spread are given in Table 7, Table 8 and Table 9. Qualitatively, the results are in large part consistent with those obtained for quoted spreads. Effective spreads are tighter for Euro denominated bonds than for Sterling ones. As can be seen in

Figure 6, effective spreads increase with credit risk (measured by ratings), in line with the prediction of theoretical models. Table 9 reports our estimates of the effective spread for different transactions sizes. In line with the analyses conducted by Goldstein, Hotchkiss and Sirri (2005) and Edwards, Harris and Piwowar (2005) for the US bond market, we find that spreads decrease with trade size.

Our estimates of effective spreads in the €denominated corporate bond market are remarkably tight. In 2005, for Euro denominated bonds, the effective half spread is such that, on average, for a bond valued at €100, the ask price would be at €100.05 and the bid at €99.95. In 2003, the corresponding figures are 100.07 for the ask and 99.93 for the bid. For Sterling bonds, the spread is less tight. For a bond valued at £ 100, in 2005, the ask price would typically be at €100.10 and the bid at €99.90. In both currencies, the order of magnitude of the effective is equal to half the order of magnitude of the quoted spread.

That our measure of effective spreads is tighter than our measure of quoted spreads is not entirely surprising. 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.

Comparison between the European and US markets

Our findings on the relationship between spreads and maturity are consistent with those of Goldstein, Hotchkiss and Sirri (2005) and Edwards, Harris and Piwowar (2005). Our results are also consistent with the result, by Edwards, Harris and Piwowar (2005), 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, the effective spreads we estimate for €denominated bonds are lower than their US counterparts. Consider the findings of Goldstein et al (2005) for their treatment sample of 90 bonds. For a small institutional size of \$ 250,000 to \$1,000,000, Goldstein et al

(2005) find that the half-spread is around .33% prior to TRACE dissemination and .18% after dissemination. For larger transaction sizes, above one million, the half-spread is .22% before dissemination and .135% after.

In our sample of €denominated bonds, for the same period (2003), the effective half spread for trades between €500,000 and €1,000,000 size is: .053%. For trade above one million euros, the effective half spread for €denominated bonds in our sample is .049%. And, for BBB bonds, in 2003, we find an average effective spread of .095%. Thus, controlling for sample period (2003) and ratings (BBB), effective spreads in €denominated bonds compare favourably to their post-trade transparent US counterparts.

To improve our understanding of the European corporate bond market, we conducted extensive interviews with buy-side and sell-side participants in this market. They mentioned to us that the supply of liquidity is much more competitive in the €zone than in the UK or the US. In the US, 5 to 6 very large financial institutions dominate the market. In the UK also, the number of financial institutions actively offering dealership services is limited. In contrast, in the €zone, there is a large number of significant players in this market. Each of the large countries has about three banks actively dealing in corporate bonds. For the smaller countries the number may range between one and three. Thanks to the €the market is well integrated. A Dutch bank can quote prices on German bonds to a French institution. Hence, tight effective spreads for €denominated bonds are likely to stem from competition between dealers to supply liquidity.

IV.4) Information content of trades

In this subsection we report findings on the information content of trades, based on the merged quotes dataset (IIC) and trades dataset (TRAX).

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, as well as the stock market, as a vehicle for their trades. This is especially true for bonds with low ratings. As far as we know, however, the hypothesis that trades in the corporate bond market can reflect private information has not been tested so far.

The information content of the n^{th} trade in bond i on day t can be expressed as:

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

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 (9) 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 (9) will be equal to 0.

The conditional expectations $E[v_i | H_{i,n,t}^+]$ and $E[v_i | H_{i,n,t}^-]$ are not directly observable for the econometrician. However, as mentioned above, assuming that: $M_{i,t-1} = E(v_i | H_{t-1})$, we have:

$$E[v_i | H_{i,n,t}^-] = M_{i,t-1} + \varepsilon_{i,n,t},$$

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 ($E(\varepsilon_{i,n,t} | H_{t-1}) = 0$.) Similarly, $M_{i,t} = E(v_i | H_t)$ yields:

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

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:

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

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

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

If trades direction is unpredictable, as in Kyle (1985), we also have that:

$$E[Z_{i,n,t} \varepsilon_{i,n,t}] = 0.$$

Hence, denoting by EA the empirical average, we have that:

$$EA[Z_{i,n,t} (M_{i,t} - M_{i,t-1})].$$

is an unbiased estimator of the information content of trades.

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.

Findings

Our results on the information content of trades are in Table 10 and 11 and Figure 7. For each bond in our sample, we computed the average information content of trades. Then we computed the mean and standard deviation of these averages across bonds. The overall results, for all the bonds in our sample, are in Table 10. The information content of trades is significantly positive for both currencies. It's greater for Sterling denominated bonds than for Euro denominated bonds. This could reflect that, for Euro denominated bonds, there is more publicly available information, for example more research or more analysts following. Correspondingly there should be less information asymmetry.

We computed two measures of the information content of a trade on day t . The first measure compares the midquote at the end of day t to the previous day closing midquote. The second measure compares the midquote at the end of day $t+1$ to the midquote at the end of day $t-1$. As can be seen in Table 10, the information content of trades is larger and more significant when measured with the latter method. This means that it takes more than a day for the information content of a trade to be reflected in market prices. Such slow incorporation of trading information into prices is likely to stem from the lack of post-trade transparency.

It is sometimes difficult to disentangle empirically the adverse selection component of the spread and the inventory cost component. Both adverse selection and inventory costs imply that quotes should move down after the dealer bought, and up after the dealer sold. Our data offers an interesting natural laboratory to disentangle the effects of adverse selection and inventory costs. The latter should be muted down as time since the trade increases. Indeed, during this time interval, the dealer can manage his inventory and unwind the trade. And this is expected even if the market is opaque. In contrast, as explained above, in opaque markets the information content of the trade should be revealed in public quotes only after some delay. Thus, in this context, the inventory cost and adverse selection theories generate two opposite

implications. Our results are consistent with the implications of the adverse selection theory, not with those of the inventory costs theory.

Table 10 also shows that the information content of trades increases with the default risk of the bonds. This is in line with theory. On the other hand, as shown in Figure 7, there is no clear link between the size of the trade and its information content.

IV.5) Competition to supply liquidity

As discussed above, there are relatively few investors in Sterling denominated market, and they tend to follow buy-and-hold strategies. This is likely to attract relatively few dealers. Correspondingly, it is likely that there is only limited competition to supply liquidity in the Sterling denominated bond market. To investigate this point, we computed, for each bond:

- i) the number of different dealers with at least one trade,
- ii) the market shares of the most active dealer,
- iii) and the market share of the three most active dealers.

The results are depicted in Figures 8, 9 and 10. In line with our expectations, the average number of active dealers is greater for Euro denominated bonds (around 25) than for Sterling denominated bonds (around 18); the market share of the most active dealer is lower for Euro denominated bonds (below 20%) than for Sterling denominated bonds (above 25%); and the market share of the three most active dealers is lower for Euro denominated bonds (below 40%) than for Sterling ones (above 50%). Note that these results are quite stable across sample years. These findings reinforce the view that the supply of liquidity is likely to be more competitive in the Euro denominated bond market than in the Sterling market.

V) Conclusion

This paper is, to our knowledge, the first high-frequency data study documenting bid-ask spreads, trading activity, and the information content of trades in the European corporate bond markets. We find that bid-ask spreads in the European corporate bond market vary with inventory bearing costs, as predicted by theory, and similarly to their US counterparts. Spreads are tighter for Euro denominated bonds than for Sterling ones. Correspondingly, the supply of liquidity by dealers is more competitive for Euro denominated bonds than for Sterling bonds. Spreads seem to be tighter in Europe than in the US, even after transparency

was enhanced by TRACE. Trades in the corporate bond market have significant information content. It takes more than one day for this content to be fully impounded in market pricing. This could reflect limited post trade transparency.

To us, the most striking finding is that spreads are tighter for €denominated bonds than for £ denominated bonds (which have the same transparency regime) and also than for US \$ denominated bonds (which, since TRACE, are more transparent.) This suggests that transparency is not the only key determinant of transactions costs in bond markets. We think that the major difference between the €denominated bond market and its £ and \$ counterparts is related to openness and competition. Our results suggest that the advent of the Euro has led to a well integrated market for European corporate bond. A large number of investors from many countries intervene in this market. And a large number of banks offer dealership services. Interviews with market participants suggested that, in the US for \$ denominated bonds or in the UK for £ ones, the number of active dealers is typically around 5 or 6, while for €denominated bonds it is much larger. Our empirical findings confirm this statement.

Thus, our findings suggest that public policy should focus on openness and competition. Barriers to entry should be minimized, both for sell-side and for buy-side participants. In that respect, the various EU directives, aiming at creating an integrated market, seem to have contributed to the liquidity of the European bond market. Our results also suggest that, as far as the bond market is concerned, UK investors and corporations would benefit from joining the Euro. Regarding transparency, the implications from our study are not clear-cut. On the one hand, transparency could increase competition, as we show theoretically in a companion paper (Biais, Declerck, Dow and Von Thadden, 2006), and this would reduce spreads. On the other hand, transparency could possibly reduce competition, and thus market liquidity, if it forced a significant number of active dealers to exit the market. As discussed in Declerck, Dow and Von Thadden (2006) it's unlikely that limited post-trade transparency would have this effect in relatively actively traded bonds. But, for less actively bonds, this could be a real issue.

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Table 1: Number of bonds in our sample

	Number of € denominated bonds with		Number of £ denominated bonds with	
	quotes data	quotes & trades data	quotes data	trades data
2003	627	310	539	336
2004	765	594	653	511
2005	812	637	647	543

Table 2: Industry structure of our sample of bonds with quotes & trades data

Panel A: Euro denominated bonds

	2003		2004		2005	
Basic Materials	9	3%	22	4%	22	3%
Consumer Goods	41	13%	75	13%	76	12%
Consumer Services	15	5%	30	5%	31	5%
Financials	141	45%	267	45%	293	46%
Health Care	2	1%	5	1%	5	1%
Industrials	21	7%	44	7%	47	7%
Oil & Gas	8	3%	20	3%	22	3%
Technology	2	1%	2	0%	3	0%
Telecommunications	39	13%	52	9%	59	9%
Utilities	32	10%	77	13%	79	12%
	310		594		637	

Panel B: Sterling denominated bonds

	2003		2004		2005	
Basic Materials	6	2%	7	1%	7	1%
Consumer Goods	20	6%	41	8%	42	8%
Consumer Services	38	11%	50	10%	50	9%
Financials	188	56%	300	59%	326	60%
Health Care	2	1%	2	0%	2	0%
Industrials	20	6%	24	5%	24	4%
Oil & Gas	5	1%	13	3%	14	3%
Technology	1	0%	1	0%	1	0%
Telecommunications	13	4%	18	4%	19	3%
Utilities	43	13%	55	11%	58	11%
	336		511		543	

Table 3: Structure by maturity & rating of our sample of bonds with quotes & trades data, in 2005

Table 3, Panel A: Euro Denominated Bonds

The first four columns (AAA, AA, A and B) refer to bonds which kept the same rating from January to September 2005. 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	AAA/AA	AA/A	A/AA	A/BBBBBB/A	TOTAL	
1	2 (1)	6 (3)	18 (6)	17 (8)	0	0	1	0	44 (18)	
2	5 (4)	12 (11)	36 (25)	32 (27)	1	0	0	0	90 (72)	
3	6 (4)	13 (10)	34 (23)	22 (16)	0	0	2	1	84 (59)	
4	2 (1)	20 (16)	46 (45)	25 (24)	1	0	0	0	98 (88)	
5	4 (3)	15 (13)	45 (37)	21 (19)	0	0	1	1	91 (77)	
6	0 (0)	13 (10)	40 (35)	27 (21)	1	0	2	1	88 (71)	
7	1 (1)	8 (2)	43 (32)	21 (15)	1	0	0	1	79 (53)	
8	0 (0)	8 (6)	24 (21)	4 (4)	0	0	0	1	38 (32)	
9	1 (0)	10 (9)	33 (32)	15 (14)	1	0	1	0	62 (59)	
10	1 (1)	12 (7)	60 (45)	16 (12)	0	0	0	0	91 (67)	
15	0 (0)	3 (3)	14 (13)	6 (5)	0	1	0	0	25 (22)	
20	0 (0)	4 (1)	8 (7)	2 (1)	0	0	0	0	14 (9)	
Longer	0 (0)	2 (1)	3 (3)	4 (3)	0	0	0	0	11 (9)	
TOTAL	22 (16)	126 (92)	404 (324)	212 (169)	5	1	7	5	33	815 (636)

Table 3, Panel B: Sterling Denominated Bonds

The first four columns (AAA, AA, A and B) refer to bonds which kept the same rating from January to September 2005. 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.

	<i>AAA</i>	<i>AA</i>	<i>A</i>	<i>BBB</i>	<i>AAA/AA</i>	<i>AA/A</i>	<i>A/AA</i>	<i>A/BBB</i>	<i>BBB/A</i>	<i>TOTAL</i>
1	0 (0)	4 (3)	7 (5)	3 (2)	0	0	0	0	0	14 (10)
2	3 (3)	17 (16)	19 (17)	16 (13)	0	1	0	0	0	56 (50)
3	5 (5)	9 (7)	18 (15)	11 (10)	0	0	0	1	1	45 (39)
4	2 (2)	17 (15)	15 (15)	11 (9)	2	0	0	1	0	48 (44)
5	3 (3)	11 (9)	23 (19)	10 (10)	1	0	1	0	0	49 (43)
6	2 (2)	9 (6)	19 (17)	9 (6)	0	1	2	0	2	44 (33)
7	1 (1)	8 (6)	7 (6)	9 (9)	1	0	0	0	0	26 (23)
8	0 (0)	4 (3)	11 (10)	10 (7)	1	0	0	0	1	27 (22)
9	1 (1)	8 (5)	5 (5)	13 (13)	0	0	0	0	0	27 (24)
10	2 (2)	6 (6)	40 (33)	23 (17)	1	0	0	2	0	74 (61)
15	5 (5)	13 (12)	50 (44)	31 (21)	2	0	1	2	3	107 (88)
20	3 (3)	9 (6)	45 (40)	16 (15)	0	1	0	0	0	74 (65)
Longer	10 (7)	10 (5)	29 (22)	7 (6)	0	1	0	0	2	59 (43)
TOTAL	37 (34)	125 (99)	288 (248)	169 (138)	8	4	4	6	9	650 (545)

Table 4: Average daily number of trades by maturity.

	EUR			GBP		
	2003	2004	2005	2003	2004	2005
1	18,11	31,87	10,75		6,30	2,42
2		6,44	5,22		4,72	2,58
3	9,58	7,57	8,76	1,90	4,12	2,73
4	5,95	4,13	4,00	2,17	2,66	2,26
5	7,68	7,36	5,73	3,02	3,67	2,99
6	3,87	4,47	3,56	3,20	3,76	4,32
7	4,81	5,28	4,28	2,96	3,32	3,35
8	3,33	3,00	2,76	2,04	2,19	2,33
9	4,70	3,62	3,33	2,57	3,53	2,97
10	6,84	6,91	5,06	2,33	3,49	3,61
15	3,44	4,84	4,43	2,23	3,86	2,63
20		9,71	6,03	1,96	2,91	2,31
25	12,46	12,63	14,32	2,47	2,82	3,00

Table 5: Average trade size in the TRAX sample.

Panel A: Euro Denominated Bonds. Trade size in Euros.

	Mean across bonds of average trade size	Minimum across bonds	Median across bonds	Max across bonds
2003				
All bonds	955 620	132 169	880 454	4 300 000
AAA	409 836	203 786	296 557	904 872
AA	791 010	172 424	576 209	2 300 000
A	1 017 366	296 302	932 036	2 656 500
BBB	933 737	132 169	866 147	3 207 456
2004				
All bonds	1 020 534	101 658	941 119	3 560 778
AAA	464 536	106 047	331 948	1 498 957
AA	891 382	131 019	646 501	3 026 689
A	1 068 225	122 988	967 422	3 560 778
BBB	1 041 011	101 658	978 335	2 650 368
2005				
All bonds	949 388	117 961	893 355	2 830 033
AAA	383 170	117 961	382 158	1 124 852
AA	771 348	131 643	564 211	2 359 688
A	1 006 750	122 814	947 353	2 830 033
BBB	998 751	190 680	914 511	2 361 513

Panel B: Sterling Denominated Bonds. Trade size in Sterling

	Mean across bonds of average trade size	Minimum across bonds	Median across bonds	Max across bonds
2003				
All bonds	743 184	72 749	733 244	1 682 080
AAA	1 016 285	365 282	987 700	1 623 061
AA	730 820	219 333	661 935	1 581 384
A	766 714	72 749	791 641	1 682 080
BBB	662 568	162 207	644 441	1 412 339
2004				
All bonds	867 867	48 961	818 905	2 411 575
AAA	767 750	191 849	524 490	2 411 575
AA	779 747	115 201	680 751	1 867 004
A	948 428	48 961	940 260	2 317 812
BBB	775 764	171 989	778 019	2 378 477
2005				
All bonds	872 151	49 901	813 509	3 692 000
AAA	749 951	96 941	578 458	1 861 564
AA	689 775	86 547	521 710	3 692 000
A	965 488	49 901	902 643	2 558 591
BBB	846 782	131 469	765 174	3 110 000

Table 6: Total trading volume per day and average trading volume per day per bond in our sample

	2003		
	€denominated bonds in €	£ denominated bonds in £	£ denominated bonds in €
Total volume	1 290 290 150	252 726 486	375 475 741
Volume per bond	4 148 843	696 216	1 034 368

	2004		
	€denominated bonds in €	£ denominated bonds in £	£ denominated bonds in €
Total volume	2 129 395 545	536 046 873	796 404 839
Volume per bond	3 590 886	1 049 015	1 558 522

	2005		
	€denominated bonds in €	£ denominated bonds in £	£ denominated bonds in €
Total volume	2 154 136 645	523 466 377	777 713 996
Volume per bond	3 387 007	964 026	1 432 254

Table 7: Effective half-spread by rating

For each bond i in our sample, we compute the empirical average over trades (n) and days (t) of: $[Z_{i,n,t} (P_{i,n,t} - M_{i,t-1}) / M_{i,t-1}]$, where $Z_{i,n,t}$ is the indicator variable taking the value +1 for customer purchases and -1 for sales, $M_{i,t-1}$ is the midquote at the end of day $t-1$ and $P_{i,n,t}$ is the transaction price. The table reports the mean and standard deviation across bonds of these averages.

Panel A: Euro Denominated Bonds**2003**

	2003		2004		2005	
	Spread	Std	Spread	Std	Spread	Std
All	0,0739%	0,000760	0,0365%	0,000329	0,0512%	0,000635
AAA	0,04999%	0,000326	0,02930%	0,000161	0,01325%	0,000070
AA	0,07489%	0,000706	0,03964%	0,000437	0,05658%	0,000912
A	0,06896%	0,000578	0,03621%	0,000293	0,04496%	0,000394
BBB	0,09469%	0,001059	0,03859%	0,000346	0,06690%	0,000853

Panel B: Sterling Denominated Bonds**2003**

	2003		2004		2005	
	Spread	Std	Spread	Std	Spread	Std
All	0,1942%	0,001874	0,1076%	0,001263	0,1039%	0,001153
AAA	0,24843%	0,002161	0,05305%	0,001595	0,08970%	0,000905
AA	0,10510%	0,001139	0,08556%	0,000938	0,08011%	0,000890
A	0,17154%	0,001436	0,09916%	0,000767	0,09079%	0,000880
BBB	0,27233%	0,002494	0,14461%	0,001779	0,13780%	0,001641

Table 8: Effective half spread. by maturity

For each bond we compute the empirical average over trades & days of: $Z_{i,n,t} (P_{i,n,t} - M_{i,t-1}) / M_{i,t-1}$, where $Z_{i,n,t}$ takes the value +1 for customer purchases & -1 for sales, $M_{i,t-1}$ is the closing midquote & $P_{i,n,t}$ the trade price. The table reports the mean across bonds.

Panel A: Euro Denominated Bonds

<i>Years to maturity</i>	<i>2003</i>	<i>2004</i>	<i>2005</i>
3	0,0720%	0,0277%	0,0582%
4	0,0602%	0,0267%	0,0349%
5	0,0886%	0,0323%	0,0388%
6	0,0767%	0,0361%	0,0403%
7	0,0758%	0,0367%	0,0523%
8	0,0893%	0,0429%	0,0582%
9	0,0654%	0,0422%	0,0686%
10	0,0699%	0,0400%	0,0533%
15	0,0120%	0,0404%	0,0659%
20		0,0762%	0,1169%
Longer	0,1352%	0,0601%	0,1133%

Panel B: Sterling Denominated Bonds

<i>Years to maturity</i>	<i>2003</i>	<i>2004</i>	<i>2005</i>
3	0,0754%	0,0358%	0,0508%
4	0,1433%	0,0693%	0,0608%
5	0,2044%	0,0793%	0,0626%
6	0,1117%	0,0854%	0,1105%
7	0,1590%	0,0898%	0,0799%
8	0,1489%	0,0975%	0,1097%
9	0,1228%	0,1300%	0,0768%
10	0,1693%	0,1143%	0,1184%
15	0,2281%	0,1128%	0,1025%
20	0,2205%	0,1365%	0,1423%
Longer	0,3058%	0,1686%	0,1690%

Table 9: Effective half spread by transaction size

For each bond in our sample, and for the different trade sizes, we compute the empirical average over trades (n) and days (t) of: $[Z_{i,n,t} (P_{i,n,t} - M_{i,t-1}) / M_{i,t-1}]$, where $Z_{i,n,t}$ is the indicator variable taking the value +1 for customer purchases and -1 for sales, $M_{i,t-1}$ is the midquote at the end of day $t-1$ and $P_{i,n,t}$ is the transaction price. The table reports the mean and standard deviation across bonds of these averages.

Panel A: Euro Denominated Bonds

<i>Trade size in €</i>	2003		2004		2005	
	<i>Spread</i>	<i>Std</i>	<i>Spread</i>	<i>Std</i>	<i>Spread</i>	<i>Std</i>
[0. 10.000]	0,0840%	0,001521	0,0496%	0,001414	0,0595%	0,001253
(10.000. 25.000]	0,1033%	0,001397	0,0462%	0,000759	0,0625%	0,001239
(25.000. 50.000]	0,0907%	0,001275	0,0471%	0,000782	0,0555%	0,000916
(50.000. 100.000]	0,0960%	0,001174	0,0376%	0,000558	0,0538%	0,001021
(100.000. 200.000]	0,0719%	0,001309	0,0364%	0,000577	0,0611%	0,001267
(200.000. 500.000]	0,0579%	0,001158	0,0302%	0,000476	0,0555%	0,001115
(500.000. 1.000.000]	0,0531%	0,000907	0,0256%	0,000560	0,0385%	0,000934
Above 1.000.000	0,0499%	0,000890	0,0327%	0,000407	0,0430%	0,000605

Panel B: Sterling Denominated Bonds

<i>Trade size in £</i>	2003		2004		2005	
	<i>Spread</i>	<i>Std</i>	<i>Spread</i>	<i>Std</i>	<i>Spread</i>	<i>Std</i>
[0. 10.000]	0,2671%	0,004440	0,1867%	0,003085	0,1456%	0,003198
(10.000. 25.000]	0,2486%	0,004174	0,1377%	0,002532	0,1235%	0,003383
(25.000. 50.000]	0,1887%	0,006006	0,1206%	0,002128	0,1068%	0,002031
(50.000. 100.000]	0,1914%	0,003962	0,1051%	0,001898	0,1042%	0,001923
(100.000. 200.000]	0,1871%	0,003843	0,0981%	0,001915	0,1017%	0,002195
(200.000. 500.000]	0,1751%	0,002679	0,0810%	0,001325	0,0921%	0,001512
(500.000. 1.000.000]	0,1820%	0,002572	0,0797%	0,001923	0,0690%	0,002109
Above 1.000.000	0,1649%	0,001973	0,0888%	0,001247	0,0919%	0,001435

Table 10: Information content of trades, by rating

For each bond i in our sample, we compute the empirical average over trades (n) and days (t) of: $[Z_{i,n,t} (M_{i,t} - M_{i,t-1}) / M_{i,t-1}]$ or $[Z_{i,n,t} (M_{i,t+1} - M_{i,t-1}) / M_{i,t-1}]$ where $Z_{i,n,t}$ is the indicator variable taking the value +1 for customer purchases and -1 for sales, and $M_{i,t}$ is the midquote at the end of day t . The table reports the mean across stocks of these average (and in parentheses their standard deviation.)

Panel A: Information content of trades, by rating
Euro Denominated Bonds

	2003		2004		2005	
	$(M_{i,t} - M_{i,t-1}) / M_{i,t-1}$	$(M_{i,t+1} - M_{i,t-1}) / M_{i,t-1}$	$(M_{i,t} - M_{i,t-1}) / M_{i,t-1}$	$(M_{i,t+1} - M_{i,t-1}) / M_{i,t-1}$	$(M_{i,t} - M_{i,t-1}) / M_{i,t-1}$	$(M_{i,t+1} - M_{i,t-1}) / M_{i,t-1}$
All	-0,00235%	0,0085% ***	0,00236% **	0,00844% ***	0.0050 % *** (0.000411)	0.0104% *** (0.000536)
AAA	0,00082%	0,00078%	0,00569%	0,01563%	-0.0001 % (0.000071)	0.0001% (0.000110)
AA	0,01021%	0,02170% **	0,00290%	0,00797%	0.0043 % (0.000214)	0.0068% (0.000326)
A	-0,00640% *	0,00294%	0,00160%	0,00852% ***	0.0031 % ** (0.000249)	0.0080% *** (0.000368)
BBB	-0,00127%	0,01332% **	0,00442% **	0,01119% ***	0.0082 % (0.000681)	0.0165% *** (0.000839)

Panel B: Information content of trades, by rating.
Sterling Denominated Bonds

	2003		2004		2005	
	$(M_{i,t} - M_{i,t-1})/$ $M_{i,t-1}$	$(M_{i,t+1} - M_{i,t-1})/$ $M_{i,t-1}$	$(M_{i,t} - M_{i,t-1})/$ $M_{i,t-1}$	$(M_{i,t+1} - M_{i,t-1})/$ $M_{i,t-1}$	$(M_{i,t} - M_{i,t-1})/$ $M_{i,t-1}$	$(M_{i,t+1} - M_{i,t-1})/$ $M_{i,t-1}$
All	-0,00350%	0,0015%	0,01000% ***	0,01938% ***	0.0098 % *** (0.000628)	0.023% *** (0.000898)
AAA	-0,01634%	-0,04932%	0,00569%	0,01563%	0.0164 % (0.000531)	0.0156% (0.000763)
AA	-0,01947%	-0,01784%	0,00290%	0,00797%	0.00669 % (0.000391)	0.0157% *** (0.000469)
A	-0,00802%	-0,00892%	0,00160% ***	0,00852% ***	0.00723 % (0.000575)	0.0222% *** (0.000742)
BBB	-0,00793%	0,01831%	0,00442% ***	0,01119% ***	0.0091 % (0.000839)	0.0238% ** (0.001322)

Table 11: Information content of trades, by transaction size

For each bond in our sample in 2005, and for each trade size category, we compute the empirical average over trades and days of: $[Z_{i,n,t} (M_{i,t} - M_{i,t-1}) / M_{i,t-1}]$ or $[Z_{i,n,t} (M_{i,t+1} - M_{i,t-1}) / M_{i,t-1}]$ where $Z_{i,n,t}$ is the indicator variable taking the value +1 for customer purchases and -1 for sales, and $M_{i,t}$ is the midquote at the end of day t . We then compute the mean and standard deviation across bonds of these averages.

Panel A: Euro Denominated Bonds

<i>Trade size in €</i>	<i>Information</i>	
	<i>content</i>	<i>Std</i>
[0. 10.000]	0.0031%	0.000773
(10.000. 25.000]	0.0106%	0.000865
(25.000. 50.000]	0.0058%	0.000693
(50.000. 100.000]	0.0000%	0.000685
(100.000. 200.000]	0.0080%	0.000694
(200.000. 500.000]	0.0053%	0.000755
(500.000. 1.000.000]	0.0009%	0.000765
Above 1.000.000	0.0111%	0.000469

Panel B: Sterling Denominated Bonds

<i>Trade size in £</i>	<i>Information</i>	
	<i>content</i>	<i>Std</i>
[0. 10.000]	0.0019%	0.001826
(10.000. 25.000]	0.0049%	0.001496
(25.000. 50.000]	0.0055%	0.001361
(50.000. 100.000]	0.0060%	0.001229
(100.000. 200.000]	0.0094%	0.001026
(200.000. 500.000]	0.0156%	0.000879
(500.000. 1.000.000]	0.0093%	0.001030
Above 1.000.000	0.0098%	0.000721

Figure 1: Capitalization of stock & bonds relative to GDP, 2004 (Source ECB, FED)

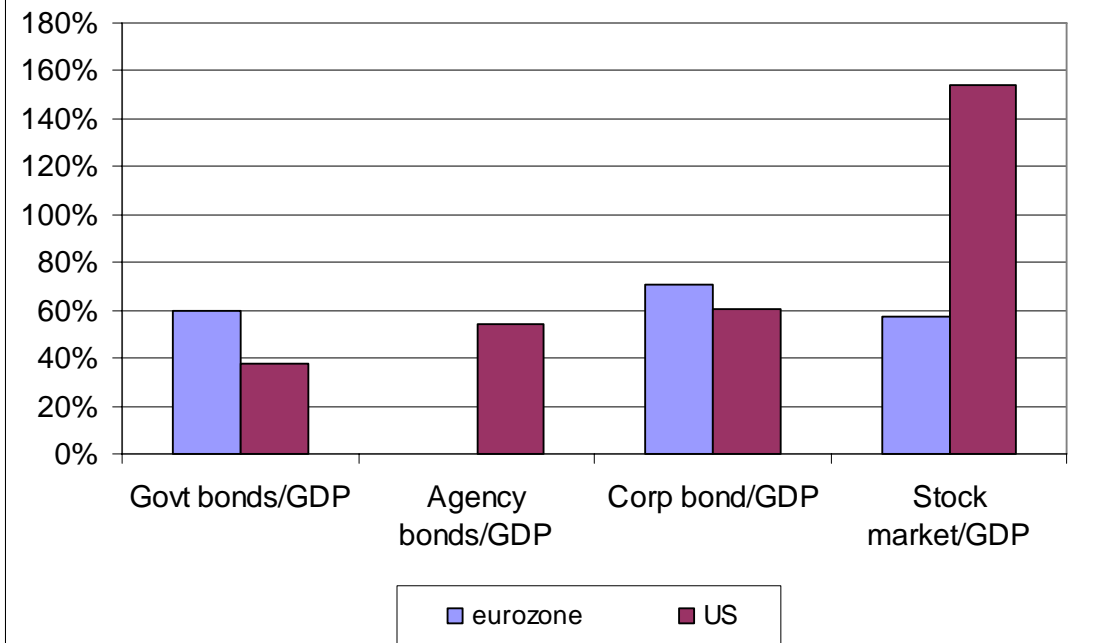


Figure 2: Number of bonds in our sample with trades and quotes data, by rating

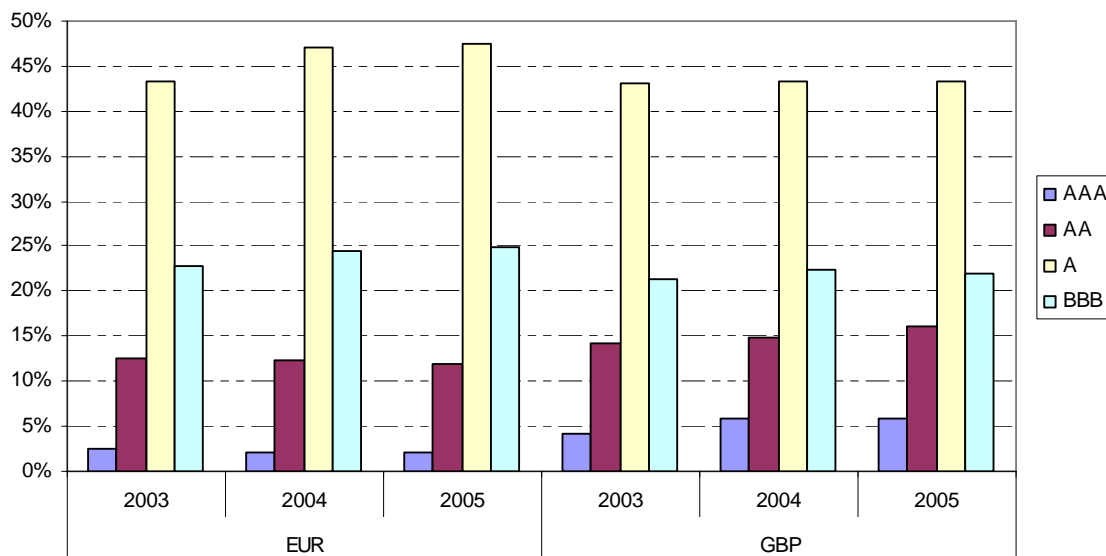


Figure 3, Panel A: Median number of trades per day, €

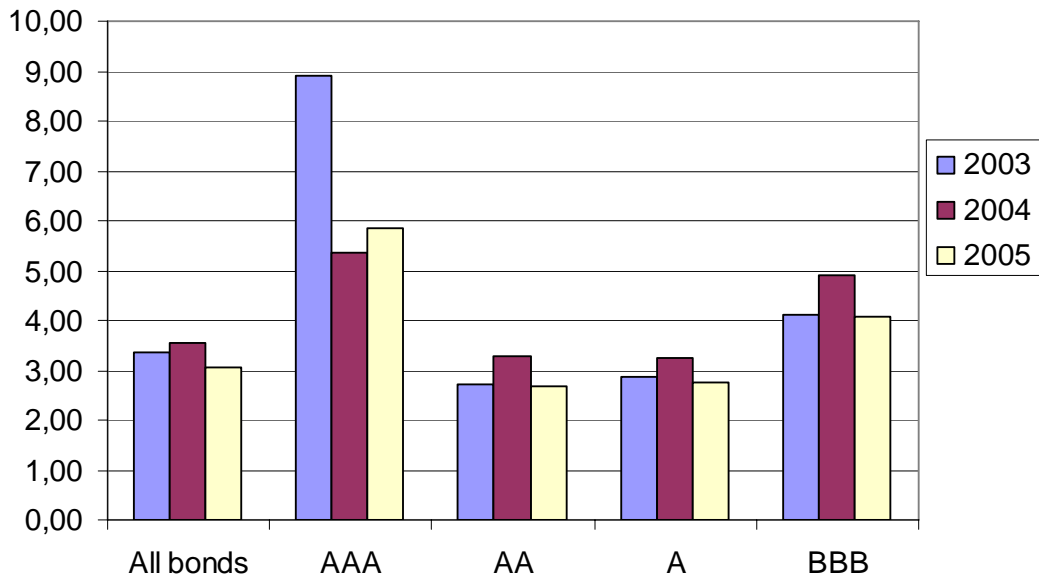


Figure 3, Panel B: Median number of trades per day, £

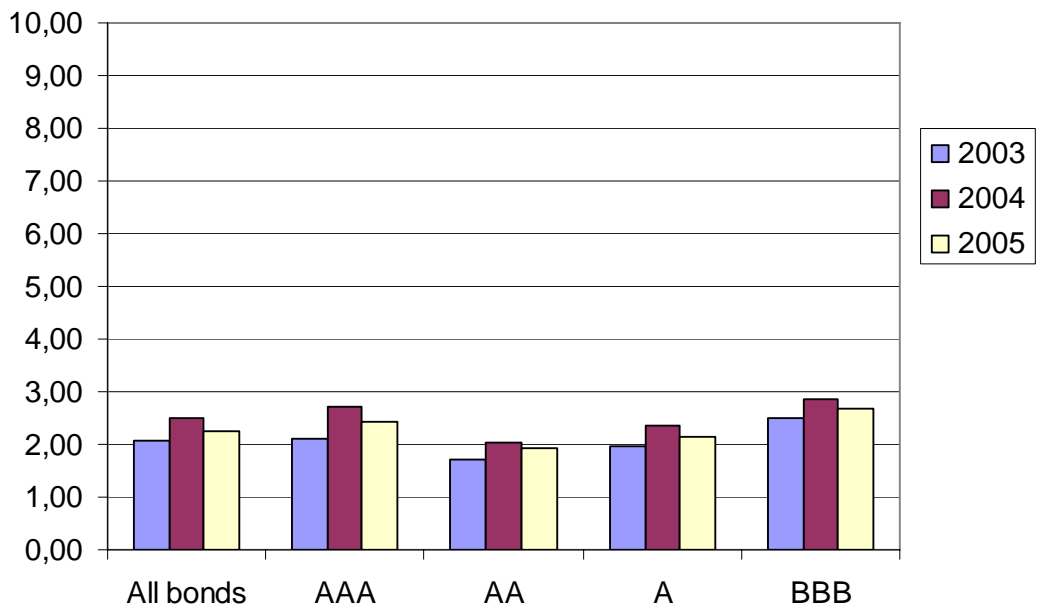


Figure 4, Panel A: Average quoted spread, €bonds, by rating

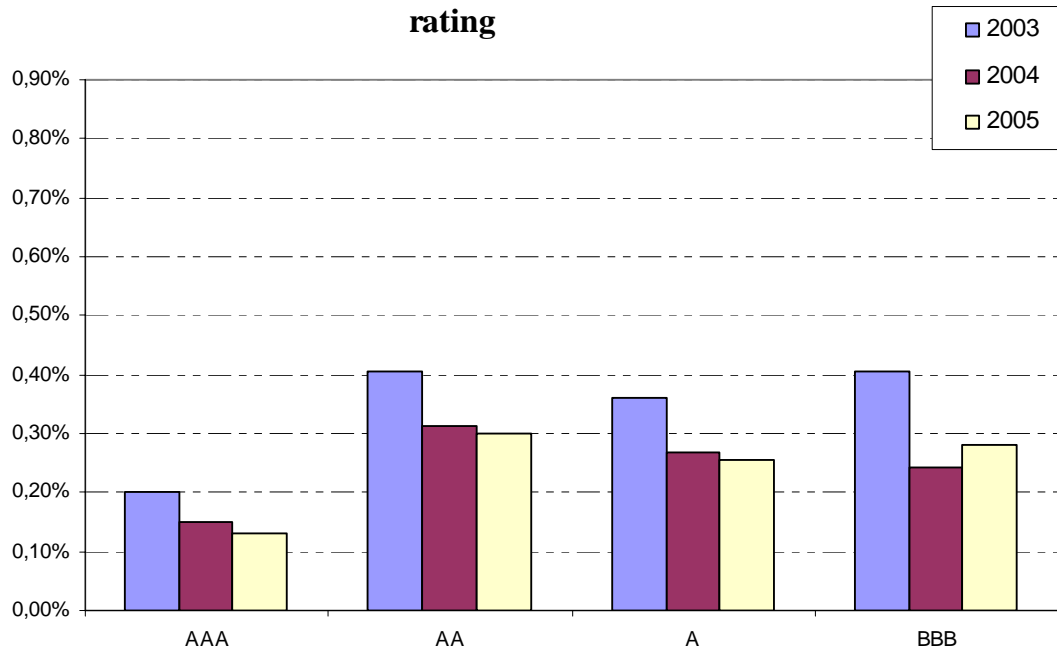


Figure 4, Panel B: Average quoted spread, £ bonds, by rating

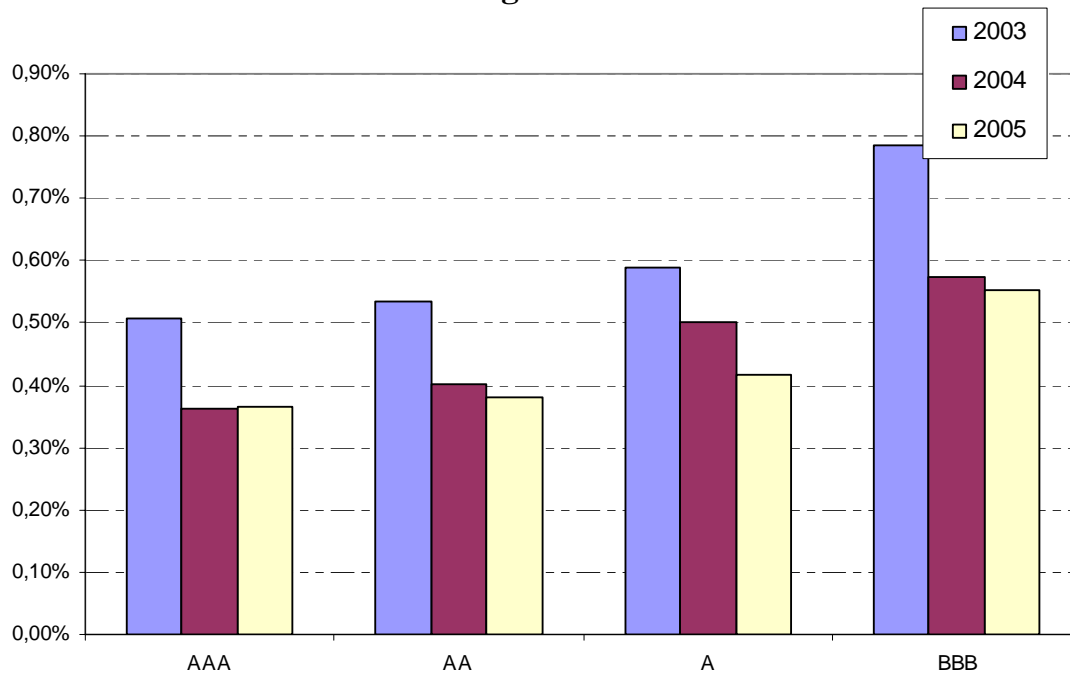


Figure 5, Panel A: Average quoted spread, €bonds, by maturity

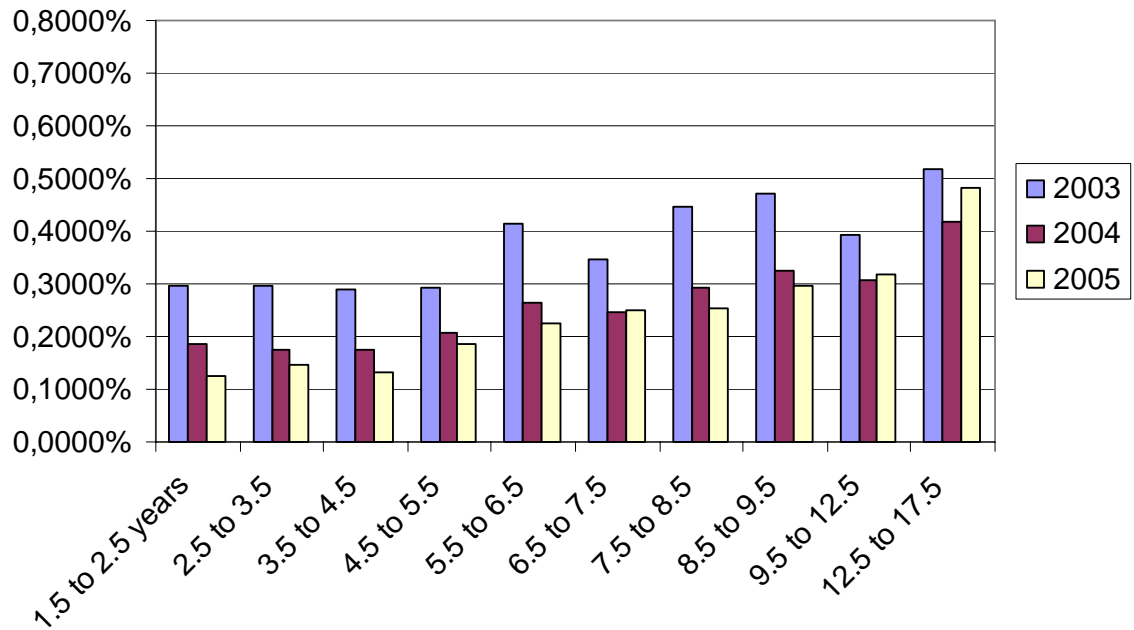


Figure 5, Panel B: Average quoted spreads, £ bonds, by maturity

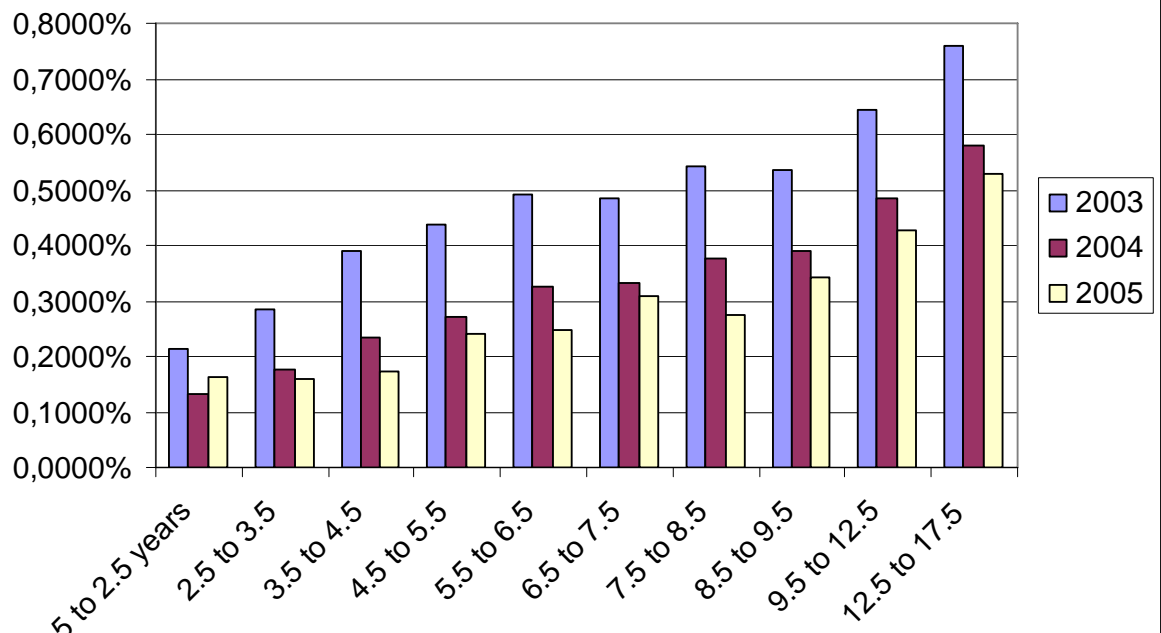


Figure 6, Panel A: Effective half spread, Euro

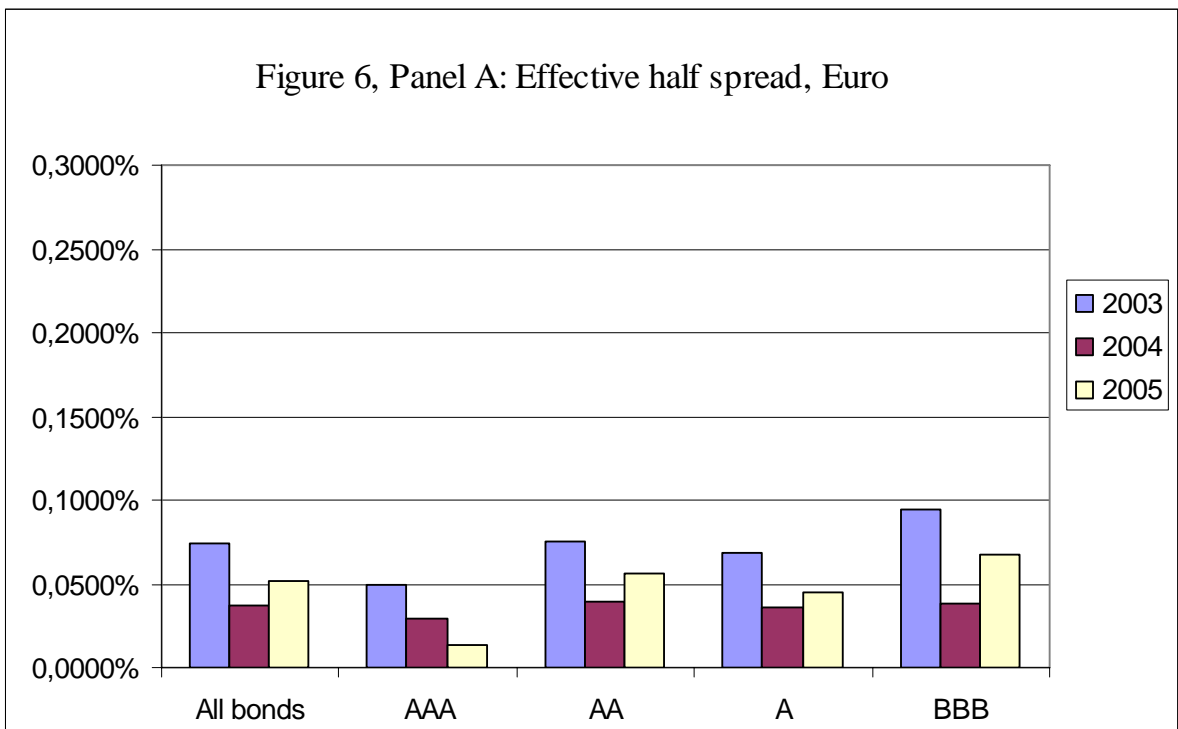


Figure 6, panel B: Effective half spread, Sterling

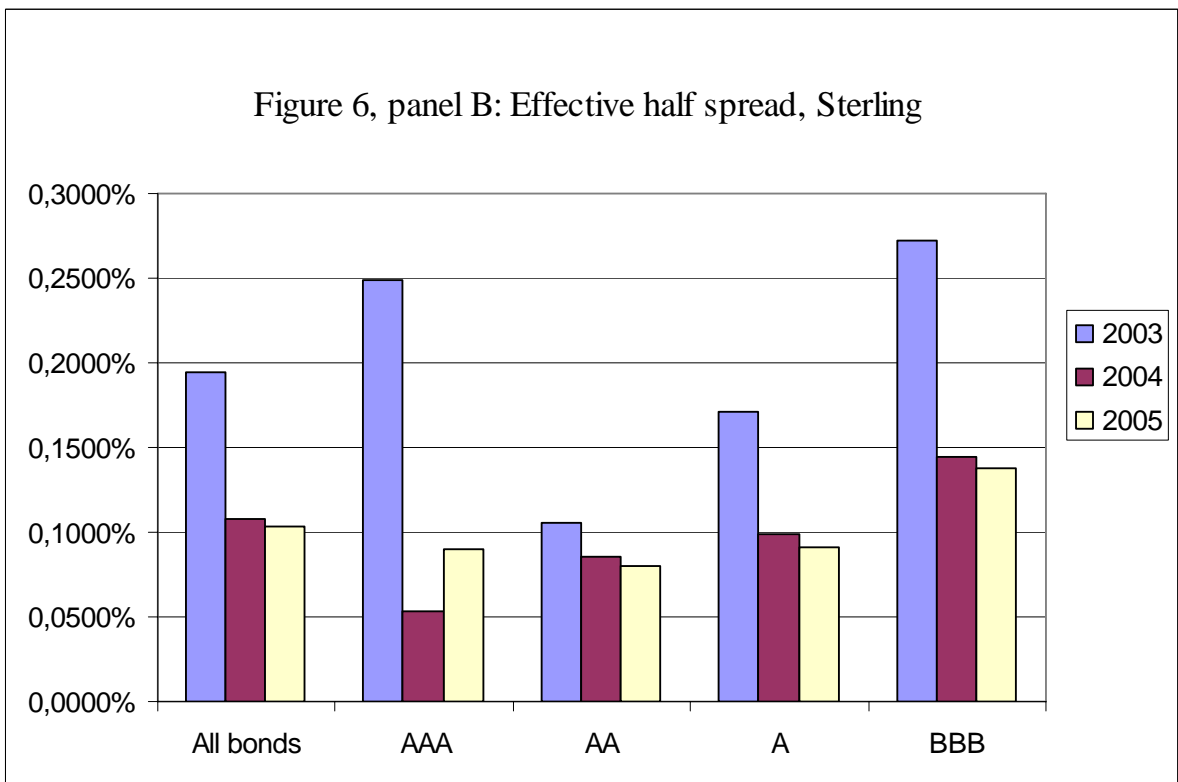


Figure 7, Panel A: Information content of trades by transaction size, euro

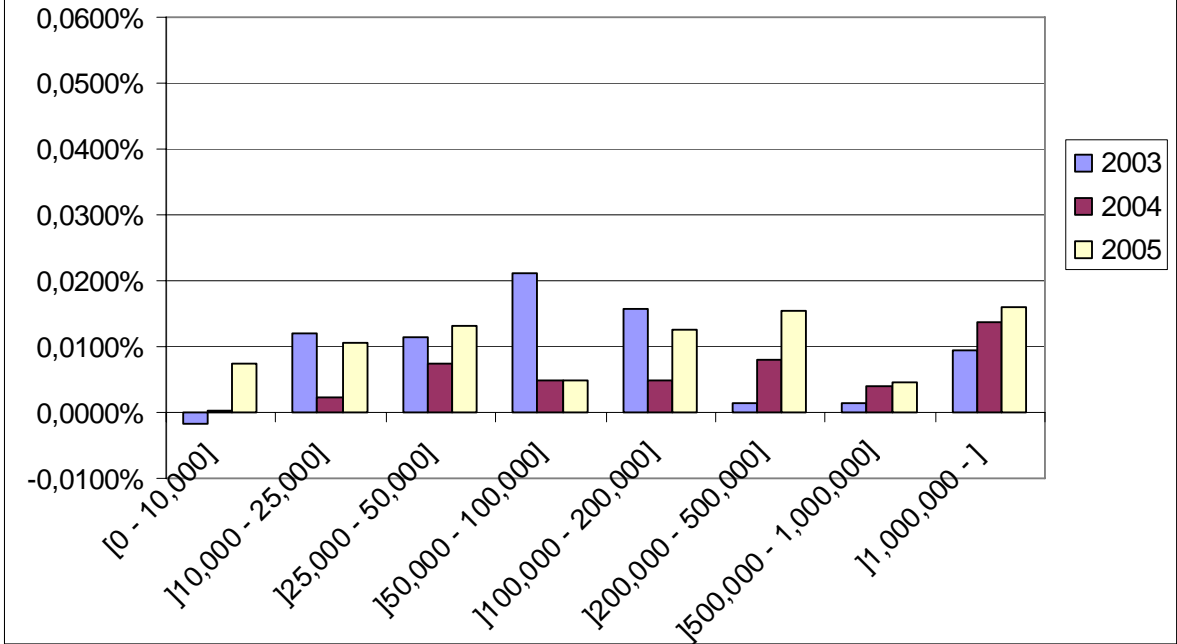


Figure 7, Panel B: Information content of trades, by transaction size, Sterling

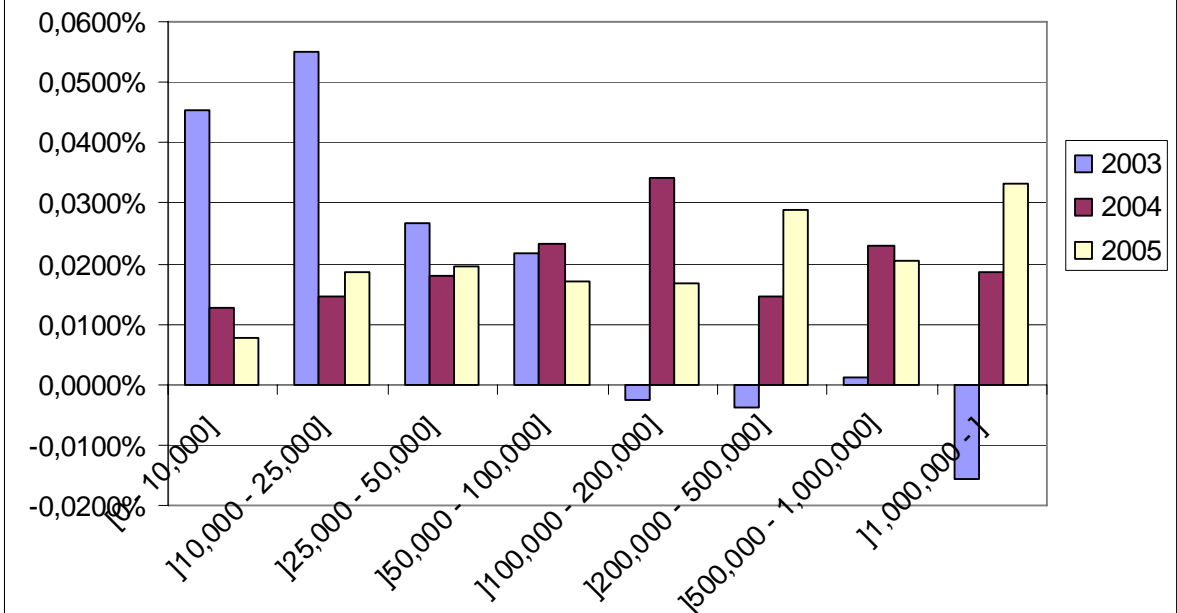


Figure 8: Number of market makers with at least one trade

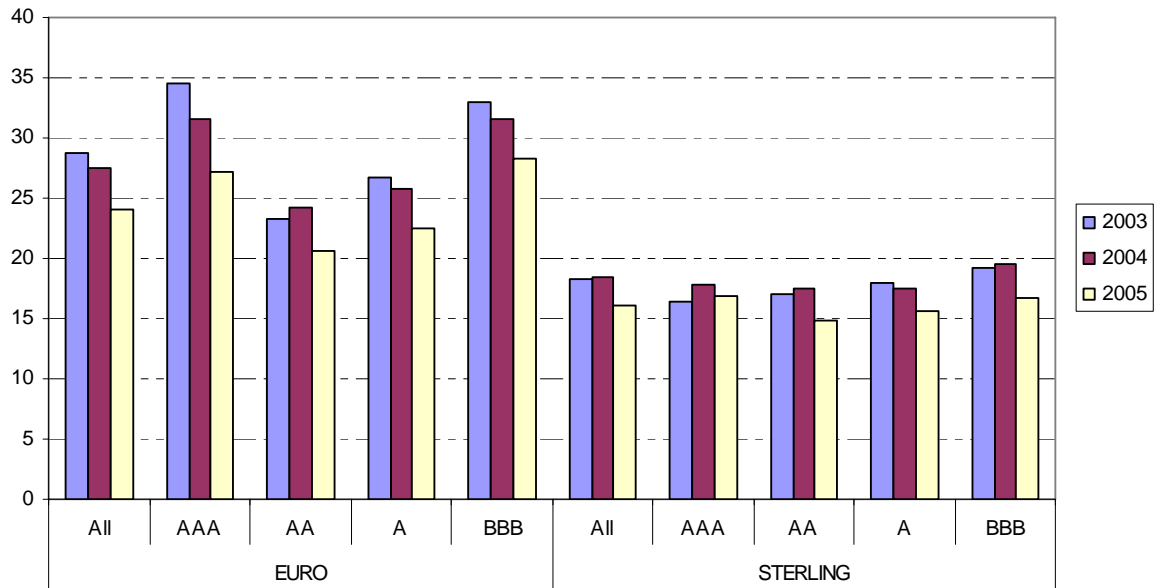


Figure 9: Market share (%) of the most active dealer

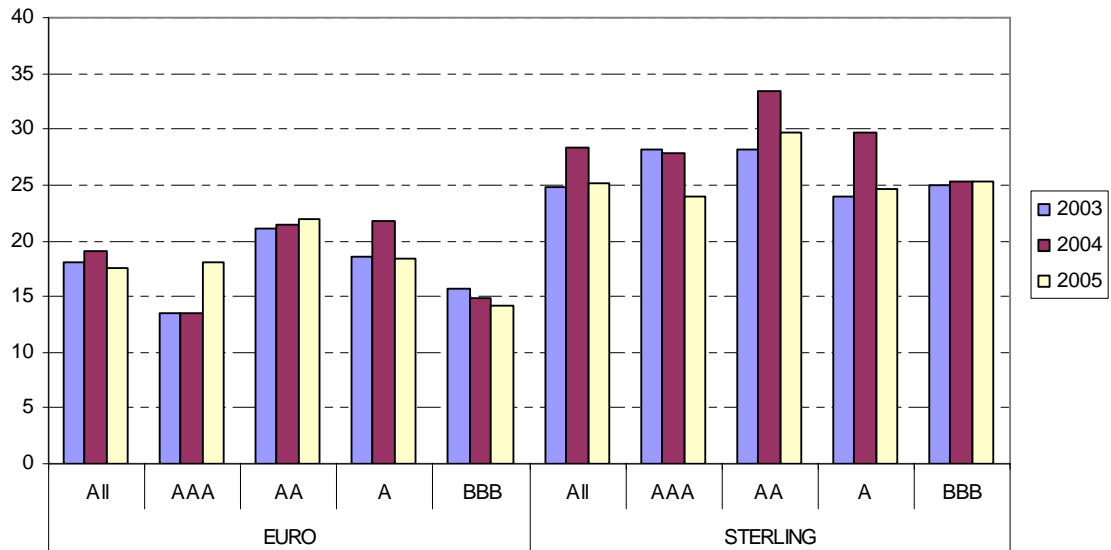
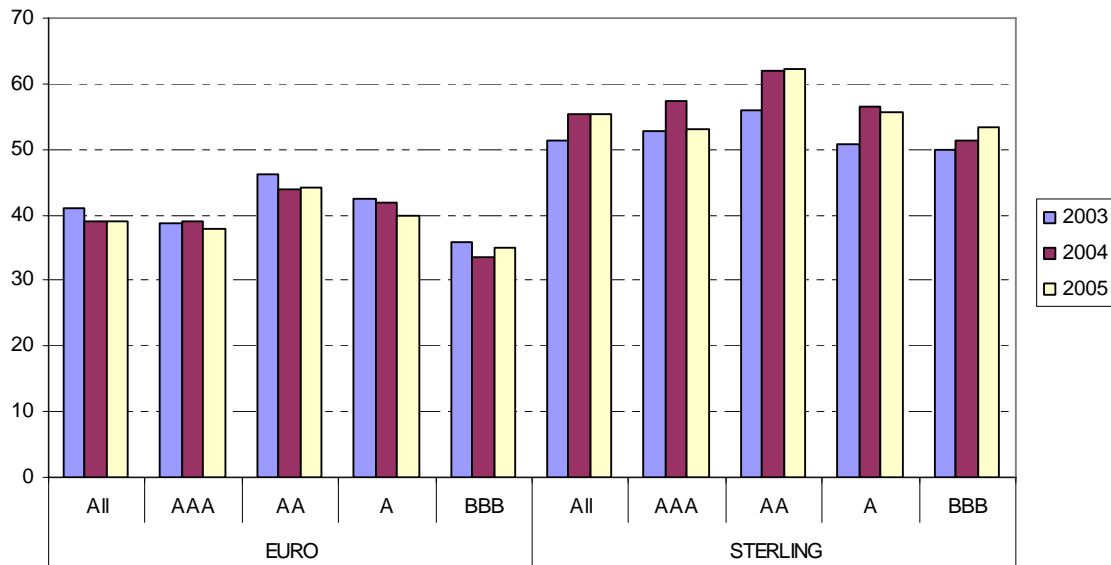


Figure 10: Market share (%) of 3 most active dealers



ⁱ While in Italy and Germany, households often directly hold bonds, in other European countries this is less frequent. The bond market still matters for households, however, who indirectly hold bonds, through mutual funds, pension funds, and insurance policies.

ⁱⁱ See e.g., the survey by Biais, Glosten and Spatt, 2005.

ⁱⁱⁱ Chakravarty and Sarkar (2003) study 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 (2004) 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.

^{iv} 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.

^v These are bid-ask spreads expressed as a function of the bond price. Hence, they correspond, for a bond priced at \$100, to an ask price of \$100.22 or 100.135. Spreads in the corporate bond market are often expressed in terms of yields rather than prices. As explained in the next section, there exists an easy formula to go from one formulation to the other.

^{vi} 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 insurance companies, pension funds or UCITs generally can't trade CDS, dealers can. This facilitates their ability to establish positions equivalent to short sales, and thus increases their risk management ability.

^{vii} Retail investors or small institutional investors do not contact dealers directly. They trade through the intermediation of their bank or of brokers.

^{viii} 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>.)

^{ix} IIC first checks whether the quotes are non negative, whether the bid is lower than the ask quote, and whether the spread is below 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.

^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).