The Relative Informational Efficiency of Corporate Retail Bonds: Evidence from the London Stock Exchange

Abstract

I examine the relative informational efficiency of the London Stock Exchange's newly launched Order book for Retail Bonds (ORB). I find that the daily returns for the stocks of the issuing firms lead the daily returns of the retail bonds born in the ORB. This finding also holds for pre-existing bonds that were transferred to the ORB from the LSE's Main Market and for the bonds with different credit ratings, issue sizes, and maturity times. I also find that bonds have very limited predictive ability for stock returns. Overall, the results provide strong evidence that the underlying stock market is relatively more efficient than the ORB. Further, the relative informational inefficiency of the ORB implies profitable trading opportunities for private investors.

JEL Classification: G12, G14

Key words: Order book for Retail Bonds; Relative informational efficiency; Corporate retail bonds; Lead-lag relation, London Stock Exchange

1. Introduction

Because stocks and bonds are claims on the same corporate assets, the arrival of publicly available information that affects the market values of these assets should concurrently affect their returns. But, if one of the two markets is relatively more efficient than the other, then the returns of the more efficient market can reflect information faster than the returns of the less efficient market. Therefore, these returns have the power to predict the future returns of the security traded in the less efficient market. As a result, the activities of informed traders lead to a lead-lag relation for the returns of the two securities.

The possible differences in the level of informational efficiency of the two markets could be due to the different types of investors and the different informational environments that prevail in the two markets. The bond market is typically dominated by sophisticated institutional investors who have better and faster access to relevant information than private investors who tend to prefer the stock market. Thus, institutional investors incorporate relevant information faster than private investors that implies the bond market should be more informationally efficient than the stock market. Then again, there are many more financial analysts that follow the stock rather than the bonds of a firm. Thus, more stock-related research is produced and disseminated to the buy-side investors, as compared to the bond-related research that is mainly limited to firms rated by credit rating agencies. Further, stock analysts tend to revise their recommendations about a firm more frequently compared to the rating agencies that follow the same firm. Hence, stock prices should incorporate relevant information faster than bond prices, and the stock market should be more informationally efficient compared to the bond market. Under both scenarios, a lead-lag relation between the returns of the two securities should be observed. Further, a growing body of literature finds that stock markets might not integrate all of the available information instantly (e.g., Hong et al., 2007; Hou, 2007). Under this scenario, the lagging market has a limited ability to fully incorporate the information reflected in the leading market. Thus, it is possible that bonds might lead in incorporating a particular type of information, such as a change in the probability of default, and lag in incorporating another type of information, such as an increase in sales revenue. Further, in the presence of information asymmetries, informed traders tend to systematically trade in either the bond or the stock market because of differences in trading fees, mechanisms, liquidity, institutional constraints, marginal tax brackets, and insider-related legislation (i.e., disclosure requirements).

In this paper, I investigate the relative informational efficiency of the recently launched electronic Order book for Retail Bonds (ORB) of the London Stock Exchange (LSE). According to the EU Prospectus Directive (2010) a retail bond is a bond that is traded in units of less than £50,000. To a large extent, the retail bond market can be thought of as the non-institutional part of the buy-side. The ORB was launched on February 1, 2010, to satisfy the increasing demand of UK private investors for easy access to retail bond trading. Indeed, a survey by the Association of Private Client Investment Managers and Stockbrokers (APCIMS) reports that demand for corporate bonds by private investors has quintupled since 2008 (LSE, 2013). The intention of the ORB was also to grant UK small- and medium-sized firms direct access to an untapped segment of the debt market. The APCIMS estimates that in a few years the ORB is likely to attract an extra £20 billion per year of fresh investment to the UK corporate debt market. The importance of this new source of financing for small- and medium-sized firms and its relevance to the recovery of the UK economy is well highlighted in the *Breedon Report* that recommends, among other things, that the United Kingdom needs to "*increase the UK retail investor appetite for corporate bonds*" (DBIS, 2012a).[1] In the current

[1] The recommendations of the *Breedon Report* have been widely welcomed by the industry. For example, John Cridland, the Director-General of CBI, UK's premium business lobbying group, said, "*One of the CBI's ideas was to open up the UK bond markets to mid-sized firms, so it's great to see this report setting out how this can be done. To help stimulate demand for bonds issued by mid-sized businesses we need to develop a retail market, …*" (CBI, 2012).

economic environment where interest rates have reached very low levels that offer private investors limited choices in fixed income investments, and firm financing is neither easily available nor cheap; the introduction of an informationally efficient secondary market for retail bonds might significantly help small- and medium-sized UK companies to raise the much needed financing not currently available from banks.[2]

Despite the importance and the size of the bond markets, corporate bonds usually trade in a rather opaque environment with only a few market professionals that have access to information such as the prices at which dealers are willing to transact and the actual prices of completed bond trades. [3,4] As a result, the literature on various aspects of the corporate bond markets is quite limited and rather inconclusive. On one hand, a number of studies find that stock returns lead bond returns and, therefore, the stock market is relatively more efficient than the bond market (e.g., Downing et al., 2009; Kwan, 1996; Blume et al., 1991; Cornell and Green, 1991; Hong et al., 2012; Gebhardt et al., 2005). On the other hand, Hotchkiss and Ronen (2002), Ronen and Zhou (2013), and Bittlingmayer and Moser (2014) show that no evidence exists that stock returns systematically lead bond returns, or that the stock market is more efficient that the bond market. According to Downing et al. (2009), Hotchkiss and Ronen (2002), and Alexander et al. (2000), these conflicting findings could be attributed to the opaque nature of the corporate bond market and to the complex relation between the returns of a firm's stock and its publicly traded high yield debt that exhibits both similarities and

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[2] According to figures from the Bank of England, the growth rate of stock lending to nonfinancial UK businesses was -5.2% (-£2.1 billion) in 2010, -2.1% (-£0.8 billion) in 2011, -3.7% (-£1.5 billion) in 2012, and -3.0% (-£1.1 billion) by the end of November 2013 (Bank of England, 2014).

[3] The global corporate bond market is enormous. According to the Bank for International Settlements (BIS, 2013), the global corporate bond market's outstanding amount at Q2 of 2013 was $45.65 trillion. This is about 87% the size of the global equity market and about 67% of the global GDP. The largest corporate bond market is by far the US market (46.39%, $21.18 trillion), followed by the UK (7.70%, $3.51 trillion), and the Japanese (7.61%, $3.47 trillion).

[4] As Blume et al. (1991) discuss, a published bond price might be an actual transaction price, a bid and ask average, or either a bid or an ask price. They show that the return calculated by using any of these four possible prices is upward biased, and the bias increases as the bid-ask spread widens; similar concerns are also raised by Sarig and Warga (1989) and Nunn et al. (1986).

differences. The motivation for my study is to examine for the first time how new information is incorporated into the bond prices of the newly launched ORB. Unlike existing bond markets, the ORB allows all market participants access to continuously posted bid and ask prices via live data feeds that therefore could help to minimize information asymmetries. This high level of transparency contributes to the motivation to investigate the ORB's informational efficiency relative to the underlying stock market.

The results on the relative informational efficiency of the ORB market have direct implications for investors, bond issuers, and regulators. For instance, if stocks lead bonds, then investors might buy (sell) a firm's bond after observing an increase (decrease) in the firm's stock price. The investors are also likely to face higher transaction costs in the less efficient market because of the greater variance in the pricing error (i.e., deviations of the market price from the 'fair' price). Consequently, traders might not trade as frequently or at such large volumes because of the high implicit costs (see, e.g., Edwards et al., 2007; Bessembinder et al., 2006; Goldstein et al., 2007). This is also of interest to the bond issuers because firms are likely to raise financing more easily and less expensively in an informationally efficient market. This is especially important for small- and medium-sized firms because corporate bonds typically have a maturity of between seven and ten years. This time frame provides these firms with enough time to grow because of the longer term financing compared to bank loans. Thus, the introduction of the ORB can potentially help these firms to decrease their dependence on bank borrowing and lower their cost of debt, which ultimately could benefit the British economy as a whole. However, if the ORB market is unappealing to private investors (e.g., an inefficient market), then firms might have to sell their bonds at a significant discount in order to tempt potential buyers. For regulators and supervisory bodies, the findings of this study can help them to adopt policies that could improve the efficiency of the ORB, making the UK retail bond market a level playing field for all market participants. This level field could lead to the further development of the retail bond market and the better allocation of capital resources that eventually will benefit the UK firms and economy.

I use a bivariate vector autoregression model to examine the lead-lag relation between the daily returns of the ORB corporate retail bond portfolios and the daily returns of the underlying stock portfolios. The use of bond portfolios helps to mitigate the problems related to non-synchronous data, stale quotes, and extreme differences in liquidity in the bonds in my sample that could affect the interpretation of the observed lead-lag relations. I also regress the daily returns of the retail bond portfolios on the daily returns of UK government bonds and the FTSE All Shares index to examine the sensitivity of the retail bond returns to interest rates and stock market movements. Finally, I assess the economic significance of my results for industry practitioners by examining whether the lead-lag relation between bond and stock returns represents profitable trading opportunities. In particular, I address the following questions: Is the informational efficiency of the ORB different to that of the underlying stock market? And do the empirical results have any economic significance for industry practitioners?

I find that the daily stock returns lead the daily retail bond returns for the portfolios of bonds born in the ORB, the bonds that were transferred to the ORB from the LSE's Main Market as well as for bonds of different credit quality, issue size, and time to maturity. I also find that the daily returns of the portfolios of bonds born in the ORB; the bonds that were transferred to the ORB from the Main Market; and of the high yield, not rated, and the middle maturity bonds are significantly related to the daily returns of the stock market. Overall, the empirical results indicate that the underlying stock market is relatively more efficient than the ORB in incorporating publicly available information. The relative informational inefficiency of the ORB together with its low level of transaction costs imply profitable trades on retail bonds for the private investors.

The remainder of this paper is organized as follows. Section 2 provides a brief description of the ORB market. Section 3 describes the data used in this study, and Section 4 describes the methods used and presents the empirical results. In Section 5, I investigate the economic significance of the empirical results; and in Section 6, I summarize and conclude the paper.

2. The Order book for Retail Bonds of the London Stock Exchange

The ORB is an electronic retail bond market that is based on the LSE Group's highly successful Italian *Mercato Obbligazionario Telematico* (MOT) platform operated by Borsa Italiana.[5] The ORB aims to enhance the depth and liquidity of the UK retail bond market. The tax treatment of the ORB bonds is also appealing to private investors because retail bonds are exempt from a stamp duty, while those bonds that mature in more than five years after their purchase can also be included in Individual Savings Accounts (ISAs) and Self Invested Personal Pensions (SIPPs). The new market is regulated by the European Union (EU), which requires a high level of disclosure and transparency, while the Financial Conduct Authority (FCA) monitors and supervises trading. Before the introduction of the ORB, private investors could only invest in retail bonds by trading units in funds of bonds or by buying or selling on the Over-the-Counter (OTC) market any of the more than 10,000 bonds listed in the LSE's Main Market; though most of these securities are not electronically tradable. However, for

[5] There are not many organised retail bond markets globally. In addition to ORB and MOT, a well-known European retail bond market is Germany's *Mittelstand* which was launched at the same time as ORB (i.e., February 2010). As Biais et al. (2006) discuss, retail bond investors typically access the bond market via various channels of financial intermediation, typically wealth managers and brokers, who then arrange a trade with a deal or market maker. At that level, retail bond trades are rather infrequent and this is the gap ORB attempts to fill. Further, there are several screen-based quote services that have been designed for retail trades. The most well-known is Bondscape (set up by HSBC and Barclays) which can be accessed by wealth managers and brokers but not by retail investors directly. A number of market makers support Bondscape, who post two way quotes for over 350 bonds. Other popular screen-based systems include the systems created by the Royal Bank of Canada and the Deutsche Bank.

private investors, trading for the exact retail bonds they wanted was rather difficult and expensive. Thus, arguably, the launch of the ORB has created a new asset class for private investors.

The ORB is similar in design to equity trading platforms, and private investors can place limit, market, and iceberg orders via the 36 registered member participants at a flat execution cost. The trading starts with an opening auction from 08.00 to 08.45 followed by continuous electronic trading until the closure of the market at 16.30. The bonds eligible for trading on the ORB must be listed in the LSE's Main Market, be eligible for settlement via CREST (i.e., UK's settlement system), and have a denomination of less than £10,000. The standard settlement timetable for corporate retail bonds is T+3 and for government retail bonds is T+1. Eleven dedicated market makers are committed to providing sufficient levels of liquidity by continuously posting two way prices during the trading day.[6] Similarly to equity trading, the ORB allows investors to trade in sizes as small as £1 for gilts and £1,000 for corporate bonds and to observe the price discovering process via third party live data feeds. The tick size for all ORB bonds is standardized at £0.01, admission fees range from £2,500 to £4,200 for international issuers and from £5,000 to £20,000 for UK issuers, and there are no annual maintenance fees.

Although it is just over four years since the introduction of the ORB, its launch seems to have been a success. At the beginning, and in order to boost the development of the retail bond market, LSE transferred a number of selected retail bonds from its Main Market to ORB. However, since then the ORB market has successfully expanded and small- and medium-sized firms have since accessed the retail bond market. For example, initially only 59 gilts and corporate bonds were available for trading. But, by the end of January 2014, this figure had risen to 179 gilts and corporate, international,

[6] The eleven market makers are: Barclays Bank, Canaccord Genuity, HSBC Bank, Jeffries International, Investec Bank, Loyds TSB Bank, Numis Securities, Peel Hunt, Shore Capital Stockbrokers, The Royal Bank of Scotland, and Winterflood Securities.

and supranational bonds. Issuers include some of the most well-known British household names like Tesco, British Telecom Group, National Grid, GlaxoSmithKline, Morgan Stanley, General Electric Capital, Enterprise Inns, and The Royal Bank of Scotland[7]. The European Investment Fund has issued four supranational bonds and the HSBC Bank plc has issued the first international bond in the ORB that is denominated in Chinese Renminbi. The issues are usually oversubscribed and close early. Further, only £240 million was raised in 2010 but this figure grew to £1.477 billion in 2011, £2.988 billion in 2012, and £3.925 billion in 2013, with the total number of ORB dedicated issues reaching 41 by the end of January 2014. Apparently the growth in the debt amount issued by firms in the ORB is in line with the shrink in bank lending to UK nonfinancial businesses (see footnote 4 for lending figures from the Bank of England). It seems, therefore, that the ORB can potentially play a vital role in the financing of small- and medium-sized firms. The total number of trades also increased from 1,400 in August 2012 to over 8,000 in August 2013, while the average trade size decreased markedly from £289,000 in 2011 to £55,000 in 2013. The ORB born corporate bonds represent 38% of all corporate bonds on the ORB but they account for over 70% of all trading. Further, 77% of the ORB born bonds were issued by small- and medium-sized firms. This percentage clearly indicates that despite the inevitable slow start due to the challenges many new markets experience, retail bond investors are increasingly participating in the ORB market (Moretta, 2013). Encouraged by the early success of the ORB, Xavier Rolet, the LSE's CEO, disclosed that the LSE is contemplating expanding the retail bond market to continental Europe to compete directly with Deutsche Börse and Euronext (Sunday Telegraph, 2012).

[7] It may seem like a paradox that Large-Cap firms also issue retail bonds. However, this might be because firms want to diversify in terms of funding sources, provide the opportunity to the small shareholders of the firm to invest in the bonds of the firm, through their ISAs and SIPPs, and to promote the name of the firm to fund managers on roadshows.

As of January 2014, there is a total of 179 bonds available for trading on the ORB. These include 106 corporate bonds, 68 gilts, 4 supranational (i.e., issued by the European Investment Bank), and 1 international corporate bond. Of the 106 corporate bonds, 97 are fixed rate, 8 are variable rate, and 1 is an inflation-linked rate bond. Further, of the 68 gilts, 57 are fixed rate, 8 are variable rate, and 3 are inflation-linked rate bonds. There are also four perpetual corporate bonds and six perpetual gilts. In addition, of the 111 corporate, supranational, and international corporate bonds, 90 are senior and 21 are subordinated bonds. In total, there are 41 new bond issues of which 33 are fixed rate, 4 are variable rate, and 4 are inflation-linked rate issues.

Insert Table 1 about here

Table 1 displays the descriptive statistics of all of the ORB corporate bond issues and the bonds traded on the ORB. Panel A reveals that there are considerable differences in the size of the bond issues. For example, although the average bond issue is £95 million, the smallest ORB bond issue is £10 million and the largest is £350 million. The mean coupon rate is 4.779% and the minimum and maximum coupon rates are zero and 7.500% respectively.[8] Further, there are considerable differences in the characteristics of all of the bonds such as the coupon, yield-to-maturity (YTM), duration, time remaining to maturity, and maturity (Panel B). For example, the minimum coupon rate is 0.041% and the maximum is 9.625%, while maturities range from 3 years to 55 years. The mean YTM is 3.370% but the minimum is -0.384%, and the maximum is 8.248%. The characteristics of the corporate bonds also vary significantly (Panel C). For example, the mean duration is 5.81 years, and the minimum and maximum values are 0.13 years and 18.32 years respectively. The mean maturity is 15.18 years but the maturities range from 4.38 to 35 years. There is also considerable

[8] The minimum coupon rate of zero is offered by a 10-year £35 million inflation-linked issue by The Royal Bank of Scotland that pays 1.3 times any annual increase in the UK Retail Price Index (RPI).

variation in the characteristics of the ORB born corporate bonds (Panel D) and the pre-existing corporate bonds that were transferred to the ORB after its introduction from the Main Market (Panel E). For example, the YTM for the ORB born bonds is 4.651% while the YTM for the non-ORB born bonds is 3.541%. However, this is not surprising given that about 77% of the ORB born bonds were issued by Mid-Cap or smaller firms. For these firms, retail investors require a higher yield than bank deposits to be attracted to the retail bond market.

Given the observed differences in the characteristics of the ORB bonds, the empirical analysis is conducted by stratifying the sample according to credit quality, issue size, and time to maturity, as well as distinguishing between ORB born and non-ORB born corporate bonds.

3. Data and Sample

3.1. ORB corporate bond portfolios

My sample is based on the corporate retail bonds listed on the ORB and covers the time period of February 01, 2010, to February 01, 2014. The information on the coupon rate, YTM, duration, maturity, and the International Securities Identification Number (ISIN) codes was collected from LSE; the information about bond prices, credit ratings, and bid-ask spreads was collected from Thomson Reuters. I exclude from my analysis the bonds issued by firms not publicly traded: perpetual, supranational, and international bonds. I also exclude the bonds for which data of more than a year (i.e., 250 daily observations) are not available. The question of how to treat multiple bonds issued by the same firm is an important one. I follow Bessembinder et al. (2006) by forming a value-weighted portfolio of the multiple bonds issued by the same firm[9]. The portfolio's characteristics I then consider to represent the characteristics of the debt issued for that particular firm. As a result the total number of bonds available for analysis decreases from 111 to 49.

Further, given the differences in the characteristics of the ORB corporate retail bonds, *a priori*, the stratification of the sample according to the bonds' credit quality, issue size, and time to maturity makes sense. Specifically, I follow the approach of Harris and Piwowar (2006) to allocate the bonds to three portfolios according to their credit rating. For that reason, I obtain the bonds' credit ratings from Moody's, Fitch, and Standard and Poor's (S&P) at the end of the sample period.[10] I then use the descriptions of the credit quality of the three agencies to assign each credit rating to a common numeric scale from 1, for the highest credit rating (i.e., AAA), to 24 for the lowest credit rating (i.e., in default). I then calculate the average credit rating across the three agencies, and I assign each bond to a credit rating. If a bond is only rated by two credit agencies, I use the lowest rating. I then allocate the bonds to the '*Investment grade*' and the '*High yield*' equally weighted portfolios. A significant number of retail bonds are not rated by any credit agency, and therefore I allocate them to a '*Not rated*' portfolio. The '*Investment grade*' portfolio contains 39 bonds with a credit rating of BBB and higher that account for 83.34% of the debt issued by the bonds in my sample, the '*High yield*' portfolio

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[9] Bessembinder et al. (2006) discuss the three main approaches used to deal with the issue of firms with multiple bond issues. The first approach is to treat each bond as a separate observation (the *Bond Level Approach*). But, this approach is problematical because the assumption of independent data points is violated, and therefore the error terms in the VAR and regression models that I apply in Section 5 could be correlated for firms with multiple bonds. In addition, because large firms with high credit ratings usually issue multiple bonds, this approach might lead to the overrepresentation of large firms in my sample. The second approach is to choose a representative bond for each firm (the *Representative Bond Approach*) according to some criteria, which are not necessarily objective. The problem with this approach is that bonds issued by the same firm but with different characteristics tend to react differently to events that affect the firm's value. Thus, the representative bond might not accurately capture the change in the value of the firm's debt. The third approach treats the multiple bonds of a firm as a value-weighted portfolio (the *Firm Level Approach*). This approach has the benefit of eliminating the problem of dependent error terms in my models while it also accurately represents the value change in the firm's debt. Bessembinder et al. (2006) find that value-weighted portfolio matching approaches are more powerful than equally weighted approaches.

[10] I also examine the credit ratings of the bonds at the beginning, middle, and end of the sample period. The number of bonds that changed ratings during this time period is very small and therefore, I reasonably assume that credit rating migrations do not significantly affect my results.

contains only two bonds with a credit rating lower than BBB that account for 4.49% of the debt, and the '*Not rated*' portfolio contains eight bonds not rated by either Moody's, Fitch, or S&P that accounts for 12.17% of the debt.

I also classify the bonds into three different size categories: an issue size of less than £50 million *(Small*), £50 to £150 million (*Medium*), or above £150 million (*Large*). This is an arbitrary choice but seems appropriate given the mean (£95.49 million), minimum (£10.00 million), and Maximum (£350.00 million) size values. I then form equally weighted portfolios. The *Small* bond portfolio contains ten bonds that account for 4.74% of the debt issued by the bonds in my sample, the *Medium* bond portfolio contains 23 bonds that account for 33.82% of the debt, and the *Large* bond portfolio contains 16 bonds that account for 61.44% of the debt. Further, I classify the bonds into three different equally weighted portfolios with respect to the time remaining to maturity. These include: 22 bonds with time remaining to maturity of less than 5 years (*Near maturity*) that account for 46.94% of the debt issued by the bonds in my sample, 21 bonds with time remaining to maturity between 5 and 15 years (*Middle maturity*) that account for 31.42% of the debt, and 6 bonds with time remaining to maturity of more than 15 years (*Far from maturity*) that account for 21.64% of the debt. This is also an arbitrary choice but seems appropriate given the mean (17.6 years), minimum (3.0 years), and Maximum (55.0 years) time to maturity values. Finally, I group the bonds according to whether they were issued in ORB (*ORB born*) or transferred to the ORB from the LSE's Main Market (*Non-ORB born*), and for the respective equally weighted portfolios. Table 2 displays the summary statistics for the ORB corporate bond portfolios in my sample.

Insert Table 2 around here

The table shows noteworthy differences in the number of bonds in each portfolio. For example, the *Non-ORB born* bonds are over two times the *ORB born* bonds, there are only 2 *High* *yield bonds* compared to 39 *Investment grade* bonds, and only 6 bonds in my sample mature in more than 15 years. The table also reveals that, on average, the *ORB born* bonds offer a considerably lower coupon (5.739%) compared to the *Non-ORB bonds* (6.190%) that indicates that firms might raise financing more cheaply by issuing debt in the ORB market. The average yield of the *ORB born* bonds (4.339%) is also considerably higher, almost 100 basis points, than the yield offered by the *Non-ORB bonds* (3.341%). Despite these differences, the bid-ask spread is the same for the *Non-ORB born* and the *ORB born bonds*. Unsurprisingly, on average, the *High yield* bonds offer a considerably higher coupon (6.313%) compared to both the *Investment grade* bonds (5.865%) and the *Not rated* bonds (5.481%). The yields offered by the three bond portfolios are also considerably different with the *High yield* bonds offering the highest yield in order to tempt potential buyers. However, the transaction costs for bonds with lower credit ratings tends to be considerably higher than those for the bonds with higher credit ratings. Specifically, the average bid-ask spread for the *High yield* bonds is 1.60% compared to 0.70% for *Investment grade* bonds. The differences in coupon, yield, bid-ask spread, as well as the other characteristics of the bonds are noticeably smaller when the bonds are categorized according to their issue size. Further, Table 2 also indicates that bonds that are at least 15 years from maturity offer almost twice the yield of those that are due to mature in less than five years. However, the bid-ask spread for the *Near maturity* bonds is 0.54% while the bid-ask spread for the *Far from maturity* bonds is considerably higher at 1.18%

3.2. Associated stock portfolios

I use the ISIN to match the ORB retail bonds with the stocks of the issuing firms. Table 3 contains information about the market capitalization, the Altman's *z*-score, and the total liabilities over the total assets ratio of the associated equally weighted equity portfolios.

Insert Table 3 around here

Table 3 shows that the average stock market capitalization varies from £36.7 billion for firms that have not initially issued their bonds in the ORB (but their bonds pre-existed and were transferred to the ORB from the Main Market) to £9.6 billion for firms that issued their bonds directly in the ORB. There is a considerable difference in the Altman's *z*-score (Altman, 1968), a measure of financial distress, for firms with *Non-ORB born* bonds (2.09) and the firms with *ORB born* bonds (1.44); yet, the total liabilities over the total assets ratio does not indicate any significant leverage difference. The same ratio, however, indicates that the firms that issue bonds with a low credit rating or bonds that are not rated (i.e., *High yield* and *Not rated* bond portfolios) tend to be more leveraged than the firms that issue bonds with a higher credit rating (i.e., *Investment grade*). The Altman's *z*-score indicates that firms that issue high yield bonds tend to have a higher probability of bankruptcy compared to the firms that issue investment grade bonds. However, this is not true for firms that issue non-rated bonds. Table 3 also reveals considerable difference in the average market capitalization of the firms that issue bonds of small and medium size (i.e., £11.1 and £16.9 billion) compared to the firms that issue large bonds (£53.7 billion). Notably, there is also a higher probability of bankruptcy for firms that issue small bonds as indicated by the low Altman's *z*-score. The differences in the characteristics of the firms that issue bonds with different maturity times are less significant.

3.3. Bond and stock portfolio returns

The data that I use in my analysis consists of the daily returns[11] of the retail corporate bonds on the ORB and the daily returns of the underlying stocks during the 4-year time period from February 01, 2010 (i.e., the date ORB was launched) to February 01, 2014. The daily prices, adjusted for coupon payments, of the ORB corporate retail bonds and the stock prices of the issuing firms were collected

[11] Bessembinder et al. (2006) report that using daily bond data significantly increases the power of statistical tests used to detect abnormal bond returns relative to lower frequency data. Further, the use of higher frequency data can lead to non-trading effects because of infrequent transactions for the individual bonds.

from Thomson Reuters. For firms that issued multiple bonds, I value-weight their percentage price changes to derive the return on their publicly traded debt.

Table 4 contains the descriptive statistics for the daily returns of the bond and the stock equally weighted portfolios. The bond portfolios tend to exhibit small daily returns with the exception of the *ORB born*, *High yield*, *Middle maturity* and *Far from maturity* bond portfolios, while the stock portfolios have significantly higher daily returns. However, the stock portfolios have considerably higher standard deviations as compared to their associated bond portfolios. Notably, the risk increases as the credit quality of the portfolios decreases and as the time remaining to maturity increases. The correlation coefficients between the daily returns of the bond and the stock portfolios are mostly negative and rather moderate, and only for the *High yield* portfolio is statistically indistinguishable from zero. Noticeable is also that the daily returns of the bond portfolios have a very low correlation with the daily returns of the 3-month UK government bond, implying that the ORB traded retail bonds are not significantly affected by interest rate movements.

Insert Table 4 around here

4. Methodology and Empirical Results

4.1 Examining the relative informational efficiency of the ORB market

In order to examine the lead-lag relation between the ORB bonds and the issuing firm's stock returns I assume a general structure for the relation between the bond and stock returns given by the following bivariate vector autoregressive (VAR) system:

$$R_t = c + \sum_{i=1}^{L} b_i R_{B,t-i} + \sum_{i=1}^{L} s_i R_{S,t-i} + \varepsilon_t \qquad (1)$$

where R_t is the variable set $[R_{B,t}, R_{S,t}]'$, $R_{B,t}$ is the daily return on a bond portfolio at time t, and $R_{S,t}$ is the daily return on the associated stock portfolio at time t. The c is the intercept term, b_i and s_i are the coefficient matrices to be estimated, and ε_t is the error term. The dynamics of how information is embedded into the bond and stock markets is examined by including the lagging terms in the model[12]. By including the lagged terms I minimize the risk of obtaining a spurious relation due to stale quotes or infrequent update of prices. The lag length L is determined on the basis of the Akaike Information Criterion (AIC). At firm level, in most cases, the AIC indicates a maximum lag length of order five for the daily retail bond returns and stock returns. Further, at portfolio level, in all cases, the AIC indicates a maximum lag length of order five for the daily returns of the bond and stock portfolios. Therefore the order of lags in the bivariate VAR system is set equal to five. It should be noted that Downing et al. (2009) also use a lag length equal to five for daily data and report that their findings are not sensitive to changes in lag lengths; Hotchkiss and Ronen's (2002) findings are similar. For robustness, I also use different lag lengths (i.e., three to seven) and my empirical results are insensitive to the number of lags used.[13]

The null hypothesis states that the ORB bond market and the associated stock market have equal information efficiency. Therefore, if the retail bonds and the associated stocks simultaneously

[12] The direction of the lead-lag relation is determined by the type of information released over time. Information on an increase in the firm's future cash flows should lead to an increase in the stock's price. At the same time, the firm's bonds should also increase in value because they are claims on the firm's cash flows and their default risk decreases. Thus, a positive correlation should exist between the firm's bond and stock returns. On the other hand, the arrival of information about a risky project with a potentially high return increases the default risk of the firm's bonds and leads to a lower debt value. But, the value of the stock now increases because of the potential to reap a high return. Thus, a negative correlation should exist between the firm's stock and bond returns. However, these two possible influences on the stock and the bond returns are not mutually exclusive. Thus, the signs of the estimated coefficients of the lagged stock returns in my VAR model represent the net effect of these two possibilities and cannot be safely interpreted.

[13] I test for stationarity in the daily returns of the two dependent variables, $R_{B,t}$ and $R_{S,t}$, using the Augmented Dickey-Fuller, and the Phillips-Perron tests (Dickey and Fuller, 1979; Phillips and Perron, 1988). The null hypothesis of non-stationarity is rejected by both tests for the daily time series of all the bond and stock portfolios at the 1% significance level. Further, the Johansen's cointegration test (Johansen, 1991) rejects the null hypothesis that the retail bond market and the underlying stock market are cointegrated for the time period I examine. Thus, I use the VAR system instead of a Vector Error Correction Model (VECM) system in my analysis. In the interest of brevity, the results of these preliminary tests are not included in the paper.

incorporate publicly available information, then the coefficients of all of the lagged cross-market returns should be statistically equal to zero. To test the hypothesis that stock returns do not cause the retail bond returns, I use the Granger (1969) causality test statistic which is the F-statistic of the null hypothesis that $H_0 = [b_i] = 0$, for all i. Likewise, to test the hypothesis that the retail bond returns do not cause the stock returns I conduct an F-test of the null $H_0 = [s_i] = 0$, for all i. The Granger causality test can determine whether stock (bond) returns are important in explaining bond (stock) returns. I use ordinary least squares to estimate the VAR system, and I report the results in Table 5. In general, the results strongly indicate that the lagged stock returns have predictive power for the bond returns. For example, with the exemption of the *Not rated* bond portfolio, there are many statistically significant coefficients for the lagged stock returns that help to explain the bond returns. Further, the Granger test rejects the null hypothesis that the lagged stock returns do not affect the bond returns for all but the *Not rated* bond portfolios. Further, there is weak evidence for only the *All ORB* and *Large issue* bond portfolios that the lagged bond returns lead the stock returns. Thus, my results provide strong evidence of a significant lead-lag relation between the returns of the retail bonds and the stock returns of the issuing firms. This lead-lag relation clearly indicates that the stock market is relatively more informationally efficient than the retail bond market. However, it should also be noted that the detected lead-lag relation is not clearly a causal one, and therefore it might be regarded as a joint reaction to common risk factors.

Insert Table 5 around here

My results are different from the results in Hotchkiss and Ronen (2002) who find that the informational efficiency of high yield corporate bonds is similar to that of the underlying stocks, and Ronen and Zhou (2013) who find that bond and stock markets are equally informationally efficient when liquidity and institutional features are taken into account. Further, my results are different to

Bittlingmayer and Moser (2014) who show that no evidence exists that stock returns systematically lead bond returns, or that the stock market is more efficient that the bond market. My results are closer to the results of Hong et al. (2012), Gebhardt et al. (2005), Downing et al. (2009), and Kwan (1996) who find that the stock market is relatively more efficient than the bond market. Downing et al. (2009) and Kwan (1996) also report that this higher informational efficiency varies with respect to the credit quality of the bonds. However, my findings do not considerably vary with the credit quality, the issue size, and the time remaining to maturity of the bonds, or even with whether the bonds were issued in the ORB or were transferred to the ORB from the LSE's Main Market. Downing et al. (2009) note that the difference in their results and the results of Hotchkiss and Ronen (2002) might be because of significant differences in the costs of bond transactions during the time period these two studies cover. This is because in a bond market with high transaction costs, information that induces trading in the stocks might not be of a sufficient magnitude to trigger trading in the firms' bonds. However, in the case of the ORB, the transaction costs are relatively low which implies that the arrival of information that is significant enough to trigger trading in the stock of the firm should also be of significant magnitude to trigger trading in the bonds of the issuing firm. Thus, the higher relative informational efficiency of the stock market over the ORB market cannot be explained on the basis of the significant differences in the cost of the stock and bond transactions.

A likely explanation might be the greater depth and liquidity of the stock market compared to the retail bond market. The trading culture of the more sophisticated institutional investors is typically, heavily weighted towards the stock market and the wholesale bond market. This is because more attention is paid to the stocks and the wholesale credit-rated bonds compared to the retail bonds of the same firm. For example, there are many more stock analysts than bond analysts; and stock analysis is widely disseminated to the buy-side of the market, while an analysis on bonds is predominantly limited to the bonds covered by credit agencies. These rating agencies do not revise their ratings of bonds as frequently as stock analysts revise their analyses about the stocks of the same firms. In addition, stocks are also more actively traded than corporate bonds, which are often held till maturity when they fall into the hands of the big financial institutions. Thus, on the arrival of new information, the stock and the large debt issues of a firm attract most of the trading interest of the institutional investors mainly due to the depth and liquidity of the stock market. Therefore, it is possible that the smaller and less sophisticated private investors trade in the retail bond market on the basis of the same information, but with a time lag. Under this scenario, stock prices should incorporate public information faster than the retail bonds.

4.2 Examining the sensitivity of results to interest rate, systematic and firm-specific risk

The investment grade bonds usually have quite stable future cash flows and therefore they generally are more sensitive to changes in interest rates and less correlated with stock returns. On the other hand, the future cash flows of lower quality bonds, which are more likely to default, are more sensitive to information about the value of the issuing firm's corporate assets and less sensitive to changes in interest rates. Further, the high yield bonds usually have higher coupon rates than investment grade bonds that implies shorter durations and less sensitivity to interest rates. For example, the average coupon rate and the duration for the *High yield* bond portfolio are 6.31% and 4.71 years respectively, compared with 5.86% and 5.33 years for the *Investment grade* bond portfolio.

In order to further examine the lead-lag relation documented previously, I examine the sensitivity of the ORB retail bond returns to market-wide and interest rate risks by estimating the return generating process suggested by Cornel and Green (1991). For that reason, I regress the daily returns of the ORB bond portfolios on the lagged daily returns of the bond portfolios, on the daily returns of default-free[14] securities, on the daily returns of the FTSE All Shares index, and on the lagged daily returns of the associated stock portfolios. Specifically, I assume the following return generating process:

$$R_{B,t} = \alpha + \sum_{i=1}^{L} \beta_{B,i} R_{B,t-i} + \sum_{i=0}^{L} \beta_{T,i} R_{T,t-i} + \sum_{i=0}^{L} \beta_{FTSE,i} R_{FTSE,t-i} + \sum_{i=0}^{L} \beta_{S,i} R_{S,t-i} + \varepsilon_t \qquad (2)$$

where $R_{B,t}$ is the daily return on a bond portfolio at time *t*, $R_{T,t-i}$ is the contemporaneous and lagged daily return of a UK government Treasury note of the closest matching maturity to the maturity of the bond portfolio, $R_{FTSE,t-i}$ is the contemporaneous and lagged daily return on the FTSE All Shares index, $R_{S,t-i}$ is the contemporaneous and lagged daily return of the associated stock portfolio, α is the intercept term, and ε_t is the error term. The coefficient $\beta_{T,i}$ captures the sensitivity of the bond portfolio's daily returns to changes in the rate of the default-free security with similar maturity, the coefficient $\beta_{FTSE,i}$ captures the sensitivity of the bond portfolio's daily returns to the stock market's returns, and the coefficient $\beta_{S,i}$ captures the sensitivity of the bond portfolio's daily returns to the returns of the associated stock portfolios.[15] The inclusion of the lagged terms allows me to account for the autocorrelation in the return structures of the bonds, default-free securities, market portfolio, and the associated stocks.

Insert Table 6 around here

Table 6 displays the estimated summary statistics. I report only the sum of the estimated coefficients and not the individual coefficients because their interpretation is not meaningful in the

[14] I use UK Treasury notes with different maturities. In their study, Downing et al. (2009) use the 5-year US Treasury note because it is the most heavily traded Treasury note, but they also report that their findings are insensitive to the maturity of the Treasury note used. Kwan (1996) matches bonds with risk-free interest rates by interpolation of the yields of Treasury bills with constant maturity, while Blume et al. (1991) construct risk-free bond prices by calculating the price of a portfolio of government bonds that closely matches the cash flows of the bonds.

[15] In the estimation of the coefficients, I use Generalized Method of Moments (Hansen, 1982) to take into account the problems related to the possible presence of serial correlation and heteroscedasticity in the error terms.

context of my study. Unsurprisingly, for all of the bond portfolios, the estimated intercept coefficients are statistically indistinguishable from zero. The results show that for the *All ORB*, *Non-ORB born*, *ORB born*, *High yield*, *Not rated*, and *Middle maturity* bond portfolios, the sums of the estimated coefficients for the FTSE All Shares, β_{FTSE}, are statistically significant; but the sums of the estimated coefficients for the underlying stock portfolios, β_s, are significant only for the *All ORB*, *Non-ORB*, and *Middle maturity* bond portfolios. Thus, the daily returns of the *All ORB*, *Non-ORB born*, *ORB born*, *High yield*, *Not rated*, and *Middle maturity* bond portfolios are significantly related to the systematic risk but not to the firm-specific risk. My results partially agree with the results of Hotchkiss and Ronen (2002) who report findings for a sample of 20 high yield US corporate bonds. However, contrary to their results, the sums of the estimated coefficients for the returns of the FTSE All Shares are negative for all but the *ORB born*, *High yield*, and the *Small issue* bond portfolios. But, the negative signs of the sums of the estimated coefficients for the returns of the FTSE All Shares cannot be safely interpreted because they represent the net effect of the coefficients estimated over five time lags.[16] Interestingly, the daily returns of both the *Non-ORB* born and the *ORB born* bond portfolios are significantly related to the daily returns of the FTSE All Shares index but only the daily returns of the *Non-ORB* born bond portfolio are significantly related to the daily returns of the underlying stock portfolios. Further, the estimated regression indicates that the sensitivities of the daily bond returns to interest rate movements are insignificant for all of the ORB bond portfolios. The results indicate that the daily interest rate movements do not have significant predictive power for the daily returns of the bond portfolios.

[16] In case this negative relation is true, it might be unexpected given that stocks and bonds tend to exhibit a modest positive correlation in the long run. However, it is well documented that, occasionally, this relation can be negative and persistent, especially during periods of high market uncertainty (Fleming et al., 2003; Hartmann et al., 2001).

My results are different than the previous results reported in the literature for the US corporate bond market. For example, Hotchkiss and Ronen (2002) regress the daily returns of the high yield bonds on the daily returns of the Lehman Intermediate Government Bond index and the S&P 500 index. They report coefficients of 0.580 and 0.490 respectively. Downing et al. (2009) regress the daily returns of AAA and junk rated bond portfolios on the 5-year Treasury note and the S&P 500 index returns. They report coefficients of 0.324 and -0.021, respectively, for the AAA rated portfolio, and 0.028 and 0.109, respectively, for the junk rated portfolio. Similar results are reported by Blume et al. (1991) and Cornell and Green (1991). The possible explanations for the differences in my results include the different characteristics of the private investor-based ORB bond market and the institutional investor-based US bond markets that are covered in the studies of Hotchkiss and Ronen (2002), and Downing et al. (2009). Further, the differences in results might be because of differences in the sample size of the bonds, the different time periods covered, and the different data types (i.e., bond portfolios versus individual bonds). Although the results are interesting, they should be interpreted with caution. Specifically, the *High yield* bond portfolio contains only two bonds and therefore might not be representative of the high yield sector of the ORB. In addition, the analysis uses daily returns that are determined by the FTSE All Shares index level and the bonds and stocks prices at the end of the day. Thus, if a bond only trades early in the day, then the associated stock and the FTSE All Shares index returns are likely to incorporate more recent information than the bond return.

5. Economic Significance of Results

I assess the economic significance of the lead-lag relation between the ORB bonds and the associated stocks by forming bond portfolios based on the behaviour of the past returns of the individual stocks.

Similar to Downing et al. (2009) and Lo and MacKinlay (1990), for each ORB bond portfolio, I construct a trading strategy by investing the fraction $w_{b_i,t}$ in bond b_i:

$$w_{b_i,t} = \frac{1}{N}\left(R_{s_i,t-1} - R_{m,t-1}\right) \tag{3}$$

where N is the number of stocks in the stock portfolio that corresponds to a particular bond portfolio, $R_{s_i,t-1}$ is the daily return on the stock of firm s_i at time t-1, and $R_{m,t-1}$ is the daily return on the stock portfolio at time t-1. This zero-net investment trading strategy implies that I go long (short) on the bond whose underlying stock has achieved above (below) average returns in the previous period. I rebalance the resulting portfolio periodically (i.e., every day, week, and month), and I also calculate the cumulative return from February 1, 2011, to February 1, 2014 (I reserve the period February 1, 2010, to January 31, 2011, in order to calculate the daily return of the stock portfolio). If the lead-lag relation between the stocks and bonds is economically significant without including the trading costs, then the formed portfolio of bonds should lead to an excess return.

Insert Table 7 around here

The results in Table 7 show that for all of the holding periods, the average return is close to zero for all of the bond portfolios. However, the cumulative return is positive for all of the bond portfolios and holding periods. Specifically, the highest cumulative returns are provided by the bonds that are contained in the *ORB born*, *High yield*, *Not rated*, *Small issue*, and the *Far from maturity* bond portfolios. For example, when the bond portfolios are held for one week, the cumulative returns for the *ORB born*, *High yield*, *Not rated*, *Small issue*, and *Far from maturity* categories are 2.642%, 4.678%, 6.213%, 6.866%, and 4.798% respectively. In general, the longer the bond portfolio is held, the larger the total return is. For example, for a holding period of one day, the cumulative return is 3.231% in the *Not rated* category, but for one week and one month the cumulative returns increase to 6.213% and 7.911% respectively. The profitability of this strategy ultimately depends on the cost of the bond transactions. In most corporate bond markets, transaction costs tend to be considerable and thus, any potential trading profit is likely to be eliminated in the long run.[17] However, the ORB is a market with low transaction costs that implies that private investors are likely to be able to exploit the lead-lag relation between the retail bonds and the stocks of the issuing firms.

6. Conclusion

I study the relative informational efficiency of the corporate retail bonds available for trading in the recently launched Order book for Retail Bonds in the London Stock Exchange. Although the ORB is a recent development, its launch has been a success among investors and issuers in terms of providing depth and liquidity to a market that previously, retail investors and firms could not access properly. This study contributes to the literature by showing how the arrival of publicly available information is factored into the prices of retail bonds and the issuing firms' stocks. I use daily returns for portfolios of bonds born in the ORB; pre-existing bonds that were transferred to the ORB from the LSE's Main Market; as well as for bonds of different credit quality, issue size, and time to maturity to examine the relative informational efficiency of retail bonds and stocks issued by the same firms. Specifically, I use a bivariate VAR system to investigate the lead-lag relation between the returns of the bonds and those of the issuing firms' stocks.

My results establish a significant lead-lag relation between the daily returns of the underlying stocks and the retail bonds, indicating that the stock market is more efficient relative to the retail bond market in incorporating common information. My findings do not vary with respect to the credit quality, the issue size, and the time remaining to maturity of the bonds, or even with respect to whether

[17] Edwards et al. (2007) report average round-trip transaction costs of about 124 and 48 basis points for small (i.e., \$20,000) and large transactions (i.e., \$200,000), respectively, in the US OTC corporate bond market (similar results are reported in the literature by Goldstein et al., 2006; Hong and Warga, 2000; Harris and Piwowar, 2006).

the bonds were issued in the ORB or were transferred to the ORB from the LSE's Main Market. In addition, given the low cost of order execution, the cost of transactions is not a satisfactory explanation for the relative inefficiency of the ORB. Instead, the possibility exists that with the arrival of publicly available information, private investors trade in the ORB with a time lag mainly because of the depth and liquidity of the stock market. I also show that it is possible to devise economically significant speculative trades based on the lead-lag relation between stocks and bonds. Although, profitability ultimately depends on the cost of the bond transactions, the ORB is a market with low transaction costs that implies that private investors can likely exploit the lead-lag relation between the retail bonds and the stocks of the issuing firms.

Although the overall success of the ORB should be assessed over the course of many years, this study represents an important first step forward in understanding the relative informational efficiency of this retail corporate bond market. Although it might be interesting to examine additional important characteristics of the ORB, like the market's quality and cost effectiveness, such an analysis is not currently possible due to the unavailability of appropriate data. However, if appropriate data becomes available, examining additional important properties of the ORB market would be a natural extension of this study.

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Table 1: Descriptive statistics of the ORB bonds, characteristics, and issues

Table 1 displays the descriptive statistics for the ORB bond issues and all bonds, corporate bonds, ORB born bonds, and non-ORB born bonds listed on the ORB at the end of January 2014. In total there are 41 new bond issues and 6 subsequent taps of existing ORB issues. Of the 41 new bond issues, 33 are fixed rate, 4 are variable rate, and 4 are inflation-linked rate issues. In addition to the new issues, a significant number of bonds were transferred from the LSE's Main Market to the ORB. In total, there are 179 bonds trading on the ORB that include 106 corporate bonds, 68 gilts, 4 supranational bonds, and 1 international bond. Of the 68 gilts, 57 are fixed, 8 are variable, and 3 are inflation-linked rate bonds. Further, 97 corporate bonds are fixed, 8 are variable, and 1 is inflation-linked rate bonds. There are also 6 perpetual gilts and 4 perpetual corporate bonds that are excluded from the calculations of 'Duration', 'Years to maturity', and 'Maturity'. The calculations of 'Duration', 'Years to maturity', and 'Maturity' refer to the end of January 2014. Of the 111 corporate, supranational, and international bonds, 90 are senior and 21 subordinated bonds. The term 'Senior' describes bonds that have priority over 'Subordinated' bonds in the case of a bankruptcy. '*s*' is the total number of bond issues in the ORB, '*N*' is the total number of bonds on ORB, '*n*' is the total number of corporate bonds on ORB, '*m*' is the total number of ORB born corporate bonds, and '*p*' is the total number of non-ORB born corporate bonds (i.e., those bonds transferred from LSE's Main Market to ORB). Further, 'St.Dev.' denotes the standard deviation, 'YTM' is the Yield-to-Maturity of the bonds, and 'Min' and 'Max' denote the minimum and maximum values respectively.

* The minimum coupon rate of zero is offered by a corporate bond issued by The Royal Bank of Scotland that pays 1.3 times any annual increase in the UK Retail Price Index.

** The four supranational bonds were issued by the European Investment Bank, and the one international bond was issued by HSBC Bank plc and is the first and only bond in the ORB denominated in a foreign currency (i.e., Chinese Renminbi).

Data source: London Stock Exchange.

Panel A: Issue characteristics (33 fixed rate, 4 variable rate, and 4 inflation linked rate)					
Issue sample (s=41)	Mean	Median	St.Dev	Min	Max
Size (£mil)	95.49	75.00	76.86	10.00	350.00
Coupon (%)	4.779	5.375	1.889	0.000*	7.500
Panel B: All bonds characteristics (106 corporate, 68 gilts, 4 supranational, and 1 international corporate bond)**					
Total sample (N=179)	Mean	Median	St.Dev	Min	Max
Coupon (%)	5.201	5.625	1.944	0.041	9.625
YTM (%)	3.370	3.446	1.555	0.384	8.248
Duration (years)	7.43	5.20	6.10	0.09	24.83
Years to maturity (years)	9.56	6.15	9.54	0.09	54.46
Maturity (years)	17.62	15.00	11.19	3.00	55.08
Panel C: Corporate bonds characteristics (106 corporate, 4 supranational, and 1 international corporate bond)					
Total sample (n=111)	Mean	Median	St.Dev	Min	Max
Coupon (%)	5.883	6.000	1.573	0.041	9.625
YTM (%)	3.844	4.120	1.491	1.073	8.248
Duration (years)	5.81	4.93	3.67	0.13	18.32
Years to maturity (years)	7.19	5.87	5.16	0.13	22.78
Maturity (years)	15.18	13.00	8.45	4.38	35.00

Panel D: Non-ORB born corporate bond characteristics					
Total sample (p=70)	Mean	Median	St.Dev	Min	Max
Coupon (%)	6.120	6.000	1.445	0.038	9.625
YTM (%)	3.541	3.645	1.513	1.073	8.248
Duration (years)	6.17	4.91	4.16	0.13	18.32
Years to maturity (years)	7.71	5.86	5.97	0.13	22.78
Maturity (years)	18.65	16.04	8.00	5.50	35.00
Panel E: ORB born corporate bonds characteristics (36 corporate, 4 supranational, and 1 international corporate bond)					
Total sample (m=41)	Mean	Median	St.Dev	Min	Max
Coupon (%)	5.266	5.500	1.775	1.000	7.625
YTM (%)	4.651	4.948	1.093	1.475	6.299
Duration (years)	4.85	5.06	1.47	1.52	7.96
Years to maturity (years)	5.99	5.91	2.02	1.59	11.21
Maturity (years)	7.72	7.15	1.94	5.21	15.01

Table 2: Characteristics of bond portfolios

Table 2 displays the daily average values for the characteristics of the ORB bond portfolios used in the empirical analysis. The 'Number of Bonds' gives the number of bonds in a portfolio. The 'Coupon' gives the average coupon, the 'Yield' gives the average yield, the 'Duration' gives the average duration, the 'Years to Maturity' gives the average time remaining to maturity, and the 'Bid-Ask spread' gives the average bid-ask spread of the bonds in a portfolio. The '*Investment grade*' portfolio contains bonds with a credit rating of BBB and above, the '*High yield*' portfolio contains bonds with a credit rating lower than BBB, and the '*Not rated*' portfolio contains all bonds that are not rated by Moody's, S&P, and Fitch. Bonds issued by a firm that is not publicly listed, perpetual bonds, supranational bonds, and one international bond are excluded from my analysis. I also exclude bonds for which data of less than a year (i.e., 250 daily observations) are only available. Further, when a firm issues more than one bond, I form a value-weighted portfolio of the multiple bonds whose characteristics I then consider to represent the characteristics of the debt issued by that particular firm.

Characteristic	**Number of Bonds**	**Coupon (%)**	**Yield (%)**	**Duration (Years)**	**Years to Maturity (Years)**	**Bid-Ask spread (%)**
All ORB bonds	49	5.912	3.700	5.639	7.366	0.80
Non-ORB born bonds	34	6.190	3.341	5.540	7.564	0.80
ORB born bonds	15	5.739	4.339	4.796	5.557	0.80
Credit quality						
Investment grade (above BBB)	39	5.865	3.240	5.330	7.067	0.70
High yield (below BBB)	2	6.313	5.901	4.711	5.548	1.60
Not rated	8	5.481	4.843	6.163	7.815	1.06
Issue size						
Small issue (<£50 million)	10	5.353	4.362	5.028	5.840	0.81
Medium issue (£50 to £150 million)	23	5.976	3.227	4.535	5.689	0.71
Large issue (>£150 million)	16	5.938	3.507	7.189	10.201	0.85
Time to maturity						
Near maturity: <5 years	22	6.222	2.426	2.756	3.032	0.54
Middle maturity: 5-15 years	21	5.654	4.406	6.328	7.839	0.90
Far from maturity: >15 years	6	5.688	4.675	12.679	20.187	1.18

Table 3: Characteristics of stock portfolios

Table 3 displays the daily average values for the characteristics of the associated stock portfolios. The 'Return' gives the average daily return of all firms in the associated stock portfolios over the time period examined (i.e., February 1, 2010 to February 1, 2014), and the 'Market Capitalization' gives the average market capitalization of the bond issuers at the end of the examination time period (i.e., February 1, 2014). The 'Altman's *z*-score' gives the Altman's (1968) average measure of financial distress (z >2.6 indicates that a firm is in the *safety* zone, 1.1 <z< 2.6 indicates that a firm is in the *gray* zone, and z <1.1 indicates that a firm is in the *bankruptcy* zone). The 'Total Liabilities/Total Assets' gives the average ratio of the total liabilities and the total assets of the firm.

Characteristic	**Market Capitalization (£millions)**	**Altman's *z*-score**	**Total Liabilities/ Total Assets**
All ORB bonds	26,456	1.91	0.738
Non-ORB born bonds	36,732	2.09	0.745
ORB born bonds	9,628	1.44	0.722
Credit quality			
Investment grade (above BBB)	34,278	1.94	0.777
High yield (below BBB)	965	0.50	0.617
Not rated	8,181	2.03	0.648
Issue size			
Small issue (<£50 million)	11,143	0.90	0.757
Medium issue (£50 to £150 million)	16,884	1.84	0.699
Large issue (>£150 million)	53,707	2.08	0.779
Time to maturity			
Near maturity: <5 years	33,475	2.08	0.738
Middle maturity: 5-15 years	18,368	1.58	0.724
Far from maturity: >15 years	39,815	2.15	0.807

Table 4: Descriptive statistics of the daily returns of the bond and the stock portfolios

Table 4 contains the descriptive statistics for the ORB bond portfolios and the associated stock portfolios. For both the bond and the underlying stock portfolios, 'Mean' is the average daily return, and 'St.Dev.' is the standard deviation of the daily returns. The $\rho_{B,S}$ is the contemporaneous correlation between the bond and the stock daily returns, and $\rho_{B,T}$ is the contemporaneous correlation between the bond and the 3-month UK government bond daily returns. The *p*-value of the null hypothesis that the estimated correlation is statistically equal to zero is given in parenthesis.

Characteristic	Mean (%)	St.Dev. (%)	Mean (%)	St.Dev. (%)	$\rho_{B,S}$	$\rho_{B,T}$
	Bonds (*B*)		Stocks (*S*)			
All ORB bonds					-0.318	0.006
	0.011	0.250	0.034	1.015	(0.000)	(0.836)
Non-ORB born bonds					-0.316	0.006
	0.010	0.251	0.030	0.991	(0.000)	(0.840)
ORB born bonds					-0.183	-0.026
	0.015	0.251	0.036	1.180	(0.000)	(0.477)
Credit quality						
Investment grade (above BBB)					-0.337	0.017
	0.009	0.240	0.031	1.024	(0.000)	(0.593)
High yield (below BBB)					0.031	-0.067
	0.014	0.780	0.050	2.436	(0.319)	(0.030)
Not rated					0.260	0.029
	0.011	0.456	0.038	1.048	(0.000)	(0.345)
Issue size						
Small issue (<£50 million)					-0.174	-0.055
	0.013	0.306	0.040	1.226	(0.000)	(0.112)
Medium issue (£50 to £150 million)					-0.314	0.036
	0.007	0.219	0.028	0.947	(0.000)	(0.245)
Large issue (>£150 million)					-0.283	-0.005
	0.013	0.305	0.031	1.008	(0.000)	(0.870)
Time to maturity						
Near maturity: <5 years					-0.291	0.040
	0.005	0.166	0.031	0.962	(0.000)	(0.198)
Middle maturity: 5-15 years					-0.278	-0.009
	0.015	0.325	0.036	1.114	(0.000)	(0.765)
Far from maturity: >15 years					-0.327	-0.014
	0.018	0.493	0.024	1.104	(0.000)	(0.663)

Table 5: VAR summary statistics for the daily returns of the ORB bond portfolios and the underlying stock portfolios

Table 5 presents the estimates of the following bivariate vector autoregressive model:

$$R_t = a + \sum_{i=1}^{L} b_i R_{B,t-i} + \sum_{i=1}^{L} s_i R_{S,t-i} + \varepsilon_t$$

where R_t is the variable set $[R_{B,t}, R_{S,t}]'$, $R_{B,t}$ is the daily return of the ORB bond portfolios at time *t*, $R_{S,t}$ is the daily return on the underlying stock portfolio at time *t*, and *L*(= 5) is the lag length. The *α* is the intercept term, b_i and s_i are the coefficient matrices to be estimated respectively, and ε_t is the error term. The *t*-statistics of the coefficient estimates are given in parentheses below the estimates. The '*N*' is the number of observations used in the analysis, and the 'Granger' is the *F*-statistic (*p*-value in parenthesis) of the null hypothesis that all estimated coefficients of the lagged cross-market returns are statistically equal to zero.

	Lagged Bond returns					**Lagged Stock returns**						
	b_1	b_2	b_3	b_4	b_5	s_1	s_2	s_3	s_4	s_5	***N***	**Granger**
All ORB bonds											1040	
Bond	0.206	0.012	-0.026	0.043	0.052	0.032	0.039	0.022	0.008	0.015		12.626
	(6.260)	(0.349)	(-0.776)	(1.316)	(1.608)	(4.159)	(5.028)	(2.754)	(1.029)	(1.869)		(0.000)
Stock	-0.332	0.132	-0.188	-0.050	-0.243	0.049	-0.019	-0.033	-0.056	-0.039		2.512
	(-2.396)	(0.938)	(-1.340)	(-0.356)	(-1.798)	(1.507)	(-0.575)	(-0.982)	(-1.656)	(-1.158)		(0.029)
Non-ORB born bonds											1040	
Bond	0.209	0.021	-0.020	0.035	0.043	0.035	0.041	0.024	0.010	0.011		12.881
	(6.374)	(0.636)	(-0.608)	(1.065)	(1.354)	(4.430)	(5.081)	(2.978)	(1.190)	(1.355)		(0.000)
Stock	-0.268	0.119	-0.187	-0.086	-0.221	0.043	-0.050	-0.038	-0.071	-0.038		2.183
	(-1.981)	(0.866)	(-1.363)	(-0.632)	(-1.675)	(1.312)	(-1.519)	(-1.135)	(-2.128)	(-1.126)		(0.054)
ORB born bonds											738	
Bond	-0.021	0.011	0.022	0.031	0.137	0.005	0.018	0.018	0.007	0.026		5.393
	(-0.564)	(0.311)	(0.600)	(0.873)	(3.872)	(0.631)	(2.402)	(2.343)	(0.864)	(3.436)		(0.000)
Stock	-0.041	0.026	-0.029	0.053	0.088	0.068	0.036	-0.038	-0.016	-0.024		0.085
	(-0.221)	(0.141)	(-0.156)	(0.301)	(0.493)	(1.813)	(0.954)	(-1.012)	(-0.420)	(-0.635)		(0.995)
Credit Rating												
Investment grade											1040	
Bond	0.210	0.009	-0.005	0.036	0.043	0.027	0.036	0.022	0.008	0.011		10.523
	(6.378)	(0.268)	(-0.152)	(1.083)	(1.334)	(3.673)	(4.816)	(2.870)	(1.021)	(1.379)		(0.000)
Stock	-0.296	0.054	-0.191	-0.075	-0.257	0.033	-0.049	-0.042	-0.062	-0.043		2.207
	(-1.944)	(0.365)	(-1.301)	(-0.512)	(-1.796)	(0.997)	(-1.481)	(-1.246)	(-1.847)	(-1.272)		(0.052)

High yield											1040	
Bond	-0.121	0.058	0.066	-0.080	0.009	0.008	0.044	0.030	0.026	0.005		8.718
	(-3.879)	(1.871)	(2.132)	(-2.617)	(0.280)	(0.855)	(4.489)	(3.022)	(2.633)	(0485)		(0.000)
Stock	-0.120	0.014	-0.045	0.115	0.012	0.119	-0.020	0.016	-0.042	0.016		0.646
	(-1.197)	(0.145)	(-0.452)	(1.176)	(0.118)	(3.819)	(-0.652)	(0.494)	(-1.327)	(0.513)		(0.665)
Not rated											1040	
Bond	0.025	0.018	-0.087	0.053	0.060	0.021	0.020	0.020	0.014	0.021		2.038
	(0.775)	(0.543)	(-2.704)	(1.653)	(1.864)	(1.488)	(1.443)	(1.446)	(1.010)	(1.496)		(0.071)
Stock	-0.102	0.095	-0.092	0.029	-0.052	-0.017	0.069	-0.041	-0.032	-0.036		1.245
	(-1.371)	(1.286)	(-1.249)	(0.385)	(-0.706)	(-0.530)	(2.137)	(-1.265)	(-0.983)	(-1.128)		(0.286)
Issue size												
Small issue (<£50 million)											766	
Bond	-0.007	0.059	0.021	0.069	0.130	0.042	0.025	0.029	0.011	0.030		13.328
	(-0.188)	(1.632)	(0.581)	(1.917)	(3.653)	(5.011)	(2.974)	(3.330)	(1.251)	(3.468)		(0.000)
Stock	-0.052	-0.219	-0.158	0.083	-0.072	0.048	0.028	-0.029	0.017	-0.028	0.721	
	(-0.324)	(-1.368)	(-0.991)	(0.520)	(-0.457)	(1.299)	(0.745)	(-0.760)	(0.439)	(-0.724)	(0.608)	
Medium issue (£50 to £150 million)											1040	
Bond	0.152	0.023	-0.052	0.048	0.036	0.026	0.032	0.011	0.014	0.015		8.224
	(4.611)	(0679)	(-1.558)	(1.450)	(1.097)	(3.454)	(4.220)	(1.504)	(1.872)	(1.915)		(0.000)
Stock	-0.196	-0.004	-0.117	-0.156	-0.242	0.031	-0.062	-0.040	-0.076	-0.047		1.551
	(-1.350)	(-0.030)	(-0.799)	(-1.075)	(-1.686)	(0.925)	(-1.884)	(-1.187)	(-2.265)	(-1.394)		(0.171)
Large issue (>£150 million)											1040	
Bond	0.216	-0.010	-0.001	0.039	0.040	0.032	0.043	0.033	0.011	0.003		10.584
	(6.662)	(-0.287)	(-0.036)	(1.198)	(1.278)	(3.391)	(4.545)	(3.487)	(1.134)	(0.341)		(0.000)
Stock	-0.287	0.187	-0.208	-0.032	-0.156	0.059	-0.028	-0.032	-0.077	-0.014		2.797
	(-2.557)	(1.635)	(-1.829)	(-0.280)	(-1.438)	(1.826)	(-0.867)	(-0.965)	(-2.344)	(-0.437)		(0.016)
Time to maturity												
Near maturity (<5 years)											1040	
Bond	0.202	0.005	-0.017	0.037	0.037	0.008	0.034	0.008	0.010	0.008		10.098
	(6.242)	(0.159)	(-0.500)	(1.132)	(1.169)	(1.412)	(6.197)	(1.463)	(1.892)	(1.892)		(0.000)
Stock	-0.389	0.241	-0.508	-0.282	-0.255	0.045	-0.050	-0.045	-0.088	-0.023		3.655
	(-2.021)	(1.230)	(-2.593)	(-1.459)	(-1.342)	(1.397)	(-1.541)	(-1.380)	(-2.687)	(-0.709)		(0.003)
Middle maturity (5-15 years)											1040	

Bond	0.107	0.051	-0.015	0.034	0.089	0.047	0.051	0.033	0.006	0.030		17.799
	(3.311)	(1.570)	(-0.465)	(1.060)	(2.817)	(5.177)	(5.554)	(3.579)	(0.645)	(3.239)		(0.000)
Stock	-0.245	-0.084	-0.065	0.000	-0.200	0.015	-0.012	-0.024	-0.021	-0.035		2.001
	(-1.830)	(-0.727)	(-0.563)	(-0.004)	(-1.790)	(0.479)	(-0.382)	(-0.735)	(-0.630)	(-1.048)		(0.076)
Far from maturity (>15 years)											1040	
Bond	0.164	0.003	-0.048	0.054	0.018	0.040	0.034	0.032	0.016	-0.005		4.374
	(4.987)	(0.079)	(-1.452)	(1.635)	(0.549)	(2.744)	(2.305)	(2.209)	(1.106)	(-0.340)		(0.001)
Stock	-0.157	0.062	-0.002	0.000	-0.038	0.056	-0.023	-0.024	-0.061	-0.021		1.027
	(-1.905)	(0.818)	(-0.023)	(-0.001)	(-0.512)	(1.701)	(-0.709)	(-0.733)	(-1.848)	(-0.635)		(0.400)

Table 6: Sensitivity of the ORB bond returns to interest rate and market-wide risk

Table 6 presents the estimates of the following regression models:

$$R_{B,t} = \alpha + \sum_{i=1}^{L} \beta_{B,i} R_{B,t-i} + \sum_{i=0}^{L} \beta_{T,i} R_{T,t-i} + \sum_{i=0}^{L} \beta_{FTSE,i} R_{FTSE,t-i} + \sum_{i=0}^{L} \beta_{S,i} R_{S,t-i} + \varepsilon_t$$

where $R_{B,t}$ is the daily return on a bond portfolio at time *t*; $R_{T,t-i}$ is the contemporaneous and lagged daily return of a default-free security (i.e., UK *T*-bill) of the closest matching maturity to the maturity of the bond portfolio; $R_{FTSE,t-i}$ is the contemporaneous and lagged daily return on the FTSE All Shares index; L is the number of lags and is set equal to 5; $R_{S,t-i}$ is the contemporaneous and lagged daily return on the associated stock portfolio; α is the intercept term; $\beta_{B,i}$, $\beta_{T,i}$, $\beta_{FTSE,i}$, and $\beta_{S,i}$ are coefficients to be estimated; and ε_t is the error term. The '*N*' is the number of observations used in the analysis. The *p*-values of the null hypotheses that the sum of the estimated coefficients is statistically equal to zero are given in parentheses.

	α	$\sum_{i=1}^{L} \beta_{B,i}$	$\sum_{i=0}^{L} \beta_{T,i}$	$\sum_{i=0}^{L} \beta_{FTSE,i}$	$\sum_{i=0}^{L} \beta_{S,i}$	*F*-test	N	Adj. R^2
All ORB bonds	0.000	0.232	0.000	-0.154	0.176	11.317	1040	0.186
	(0.657)	(0.000)	(0.474)	(0.007)	(0.001)	(0.000)		
Non-ORB born bonds	0.000	0.242	0.000	-0.118	0.149	11.052	1040	0.182
	(0.825)	(0.000)	(0.645)	(0.045)	(0.016)	(0.000)		
ORB born bonds	0.000	0.166	-0.001	0.098	-0.035	3.385	738	0.069
	(0.242)	(0.038)	(0.392)	(0.031)	(0.323)	(0.000)		
Credit quality								
Investment grade (above BBB)	0.000	0.240	0.000	-0.088	0.102	10.689	1040	0.177
	(0.715)	(0.000)	(0.522)	(0.131)	(0.080)	(0.000)		
High yield (below BBB)	0.002	-0.108	-0.004	0.348	0.028	5.316	1040	0.087
	(0.055)	(0.133)	(0.050)	(0.000)	(0.342)	(0.000)		
Not rated	0.001	0.033	-0.001	-0.209	0.118	6.454	1040	0.108
	(0.280)	(0.633)	(0.378)	(0.001)	(0.053)	(0.000)		
Issue size								
Small issue (<£50 million)	0.000	0.250	0.000	0.073	0.046	5.332	768	0.115
	(0.701)	(0.001)	(0.932)	(0.138)	(0.213)	(0.000)		
Medium issue (£50 to £150 million)	0.000	0.154	0.001	-0.085	0.093	10.443	1040	0.173
	(0.471)	(0.012)	(0.312)	(0.062)	(0.059)	(0.000)		

Large issue (>£150 million)	0.000	0.248	0.000	-0.066	0.092	9.418	1040	0.157
	(0.805)	(0.000)	(0.998)	(0.316)	(0.154)	(0.000)		
Time to maturity								
Near maturity: <5 years	0.000	0.211	0.001	-0.029	0.044	9.436	1040	0.157
	(0.309)	(0.000)	(0.216)	(0.370)	(0.203)	(0.000)		
Middle maturity: 5-15 years	0.000	0.214	0.000	-0.117	0.178	9.706	1040	0.162
	(0.915)	(0.000)	(0.696)	(0.047)	(0.001)	(0.000)		
Far from maturity: >15 years	0.000	0.172	-0.001	-0.047	-0.004	8.384	1040	0.140
	(0.415)	(0.005)	(0.596)	(0.563)	(0.956)	(0.000)		

Table 7: Predictability and profitability

Table 7 reports the profit or loss of the zero-net investment trading strategies based on the bond portfolios that are formed by assigning a positive (negative) weight to the bonds whose associated stock achieved an above (below) average return over the previous period. The 'Mean' gives the average return for the holding period, and the 'Total' gives the cumulative return for the period February 1, 2011, to February 1, 2014.

	Holding period					
	Day		Week		Month	
	Mean (%)	Total (%)	Mean (%)	Total (%)	Mean (%)	Total (%)
All ORB bonds	0.001	1.418	-0.001	0.832	0.001	3.164
Non-ORB born bonds	0.001	2.289	0.002	1.333	0.003	3.555
ORB born bonds	0.003	2.920	0.004	2.642	0.003	5.871
Credit quality						
Investment grade (above BBB)	0.001	1.552	0.001	1.211	0.002	3.090
High yield (below BBB)	0.002	2.651	0.005	4.678	0.007	8.144
Not rated	0.004	3.231	0.007	6.213	0.006	7.911
Issue size						
Small issue (<£50 million)	0.001	1.419	0.002	6. 866	0.005	9.931
Medium issue (£50 to £150 million)	0.001	1. 399	0.002	6.125	0.004	8.555
Large issue (>£150 million)	0.001	0.983	0.001	3.569	0.004	7.644
Time to maturity						
Near maturity: <5 years	-0.000	0.703	0.000	1.553	0.003	5.777
Middle maturity: 5-15 years	0.002	1.770	0.003	4.131	0.004	6.201
Far from maturity: >15 years	0.002	2.040	0.004	4.798	0.006	7.632