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Executive Summary

The Israeli corporate bond market is highly transparent and predominantly traded on the Tel Aviv Stock Exchange (TASE) continuous limit order book. Two thirds of the face value of the Israeli corporate bond market is listed on the TASE,[1] and approximately 90 percent of the trading volume in exchange-listed corporate bonds takes place on the exchange. In contrast, corporate bond markets in the U.S. and Europe are structured as dealer-based over-the-counter (OTC) markets; there is little-to-no volume on the exchanges, even for exchange-listed bonds (IOSCO 2004). Legislators in the U.S. appear to prefer exchange trading; in the wake of the crisis they are presently trying to move derivatives markets from OTC trading to the exchange.[2] In Europe there is at least some interest in doing the same for the corporate bond market.[3] However, exchange trading is not necessarily superior to OTC trading. This report highlights the relevant issues for assessing market quality in Israel and puts forward a detailed empirical analysis of the liquidity of the tradable corporate bond market in Israel.

In our sample we find that the Israeli corporate bond market is characterized by larger quoted spreads at *larger* trade sizes (consistent with U.S. equity markets) but larger effective spreads at *smaller* trade sizes (consistent with foreign bond markets). This trend is observed for all except the largest trade sizes, where costs again increase with trade size. Equities on the TASE exhibit the same pattern for quoted spread and effective spread distribution by trade size. Corporate bond market effective spreads on the TASE are comparable to or better than the cost of trading in corporate bonds around the world, and better than equities' effective spreads on the TASE.

Quoted inside spread (QIS) was lower for corporate bonds in January 2010 (median security's mean over the period = 96 bps) than for equities in the same period (309 bps) or for corporate bonds in March 2009 (263 bps). We find that effective spreads are substantially lower than quoted spreads (whole spread, not half spread), with transaction medians of 11.45 bps (Jan 2010 corporate bonds), 12.65 bps (Jan 2010 equities), and 13.50 bps (Mar 2009 corporate bonds).

The March 2009 period had considerably higher yield estimates than the January 2010 period. Corporate bonds in the middle decile by yield had an average yield of 10.42 percent in March 2009 and 4.59 percent in January 2010. March 2009 falls within what is considered to be the Israeli corporate bond crisis, during which many corporate bonds lost much of their value as measured by market capitalization. The March 2009 yields coincide with considerably higher transaction costs. After transaction costs, the yield estimates for March 2009 and January 2010 were much closer to each other: Subtracting the average cost of transacting NIS 100,000 over the relevant bonds results in average yield estimates of 4.05 percent and 2.55 percent in the two periods, respectively.

We also test to see if an ex-ante liquidity measure that analyzes liquidity "down the book," the CRT(D), is useful to investors. Down-the-book liquidity measures seek to capture both the price and *size* component of liquidity, answering the question: "What are my costs given that I wish to trade X number of shares or value of currency?" Benston et al. (2000) put forward the CRT(D) measurement and test it for information contribution by seeing how well it predicts subsequent transactions relative to quoted spreads in the Toronto equities market. Replicating their procedure, we find that for a sample of TASE equities, CRT(D) does contribute additional information to investors. However, we fail to find that CRT(D) contributes additional information on either a matching sample of bonds or a broad sample of corporate bonds over the relevant period.

Currently, traders on the TASE have public access to the top three best bid and ask quotes. Our finding that CRT(D) contributes added information relative to the top bid-ask quotes in the equities suggests that it may be beneficial for market participants to see greater depth on the limit order book.

In this report we focus on liquidity. We also believe that market structure and transparency can affect market stability. While we do not assess market stability in this report, we caution the reader that assessing the liquidity of varied market structures without also considering their effect on stability presents an incomplete picture.

1. Introduction

Both U.S. and European corporate bond markets are predominantly dealer-driven and operate over the counter (OTC). (For an overview of market structures, see Appendix 2.)

The International Organization of Securities Commissions (IOSCO 2004) notes that "a majority of bond trading in most SC2[4] jurisdictions occurs bilaterally, dealer-to-client." FSA (2005) reports that "the predominant form of trading in U.K. bond markets is based around the bond dealer. Dealers trade with clients either on a purely bilateral basis or, increasingly in some market segments, via multi-dealer trading platforms," and that "open order-book trading, as used in equity markets, has yet to establish a place in the U.K. bond markets." Biais and Green (2007) make the interesting point that U.S. corporate bond market trading was not always predominantly OTC. They show that volume on the NYSE was quite high until the 1940s and. They indicate that the reduction in volume on the exchange coincided with a rise in the prominence of institutional investors.

Unlike its U.S. and European counterparts, the Israeli corporate bond market is predominantly exchange traded. About 90 percent of tradable corporate bond trading by volume occurs at the Tel Aviv Stock Exchange's electronic limit order book (LOB), which functions much like many equities electronic limit order books around the world. This makes the transparency of Israel's corporate bond market very different than that of corporate bond markets elsewhere around the globe, and correspondingly makes the analysis of liquidity different as well. For these reasons, it is difficult to draw inferences from the existing literature on corporate bond market liquidity outside of Israel. This paper draws on transparency and liquidity research on foreign OTC corporate bond markets and on foreign electronic limit order book equity markets.

For researchers and policymakers addressing the U.S. and European corporate bond markets, dealer rent-extraction is a principal issue. (For a detailed review of recent academic and regulatory interest in bond market structure, see Appendix 1.) Researchers observe that, unlike equities markets in the same jurisdictions, small trades tend to have larger spreads than large trades (see Spatt 2006; Goldstein et al. 2007; Bessembinder et al 2005; Edwards et al 2005; CEPR 2006). This is taken as evidence that dealers are able to extract rents from retail investors relative to large (and possibly better informed or connected) institutional investors (Spatt 2006; Bessembinder et al. 2005). This sentiment is bolstered by an estimate that the Trade Reporting and Compliance System (TRACE) employed in the U.S. has reduced dealer corporate bond market making revenue by approximately $1 billion per year since its adoption (Bessembinder et al 2005). (See the end of the following section and also Appendix 1 for greater detail on TRACE.) Bessembinder et al. believe lower corporate bond market making revenue implies that dealers no longer have the ability to extract the same level of rents from investors.

Since the Israeli bond market functions in many ways like a transparent equity market in the U.S. or Europe, we can analyze the alternative to the dealer-driven corporate bond markets in those jurisdictions. We do not necessarily regard dealer rent-extraction as the principle issue facing the Israeli bond market. Rather, we consider the effects of liquidity at heterogeneous trade sizes to determine if heterogeneous investor types are differently affected by the Israeli corporate bond market structure.

This paper provides an overview of the structure of the Israeli bond market, descriptive statistics regarding the limit order book, and an examination of liquidity on the limit order book at heterogeneous trade sizes. It also examines liquidity "down the book" for a broad sample of Israeli bonds for an extended period of time. We analyze a large sample of bond securities for the months of March 2009 and January 2010, and, for reference, down-the-book liquidity for TASE-traded equity securities in January 2010. Employing an information contribution test put forward in Benston et al. (2000), we conclude that down-the-book liquidity measures do contribute additional information to investors in a sample of equities—consistent with the results in Benston et al.—but do not contribute additional information in a sample of bonds.

We believe this is the first paper to examine liquidity down the book for a bond limit order book. Our sample size (more than 500 bond securities for two months of trading, along with a reference group of 492 equity securities for the month of January 2010) makes this a relatively large-scale analysis of liquidity down a limit order book.

2. Transparency and Liquidity

Transparency is often divided into pre-trade and post-trade transparency (see Biais et al. 2005 and CEPR 2006). Pre-trade transparency refers to the information available to traders before a trade occurs, while post-trade transparency refers to information about trades that have already occurred. Pre-trade transparency primarily refers to the price and quantity of a security at which investors are willing to trade, together with the identity of the investor. Post-trade transparency primarily refers to the price and quantity of trades, the identity of the investors, and also the lag time between the execution of a trade and the subsequent dissemination of information about the trade. Pre-trade transparency requires intervening in the market structure, whereas post-trade transparency is to some extent separable from market structure (CEPR 2006).

Limit order books are characterized by a high degree of pre-trade transparency. IOSCO (2004) notes that: "Most exchanges provide their participants with real-time order and/or quote information, including bid and ask prices and quantities. Some exchanges show the entire depth of the market (e.g., SWX in Switzerland, BovespaFix in Brazil, Madrid Stock Exchange in Spain) while others do not. Some exchanges provide broker identity[5] (e.g., SEHK in Hong Kong, TSX in Canada) and others provide anonymous orders (e.g., NYSE in the United States)." The TASE displays the top three levels of the limit order book publicly, including price and quantity but excluding the identity of the originator of the quote.

In limit order books, demand and supply information about a security can be readily accessible if disclosed by the exchange. An investor can look at the limit order book and have clear knowledge about what it would cost her to purchase or sell at least one unit of the security.

Certain limit order books have less pre-trade transparency. For instance, the Toronto Stock Exchange began publicly disseminating its limit order book in April 1990. Before that date, although the exchange functioned as an order-driven market, only a designated market-maker had access to the book for "floor" stocks, and only exchange members had access to the book for stocks on their electronic system (Madhavan et al. 1999). In addition, crossing networks, which permit trades against a limit order book without necessarily declaring information about the orders on the book, and public exchanges that allow the submission of hidden and/or "iceberg" orders,[6] are good examples of limit order books with a lower aggregate level of pre-trade transparency.

By contrast, phone-based OTC dealer markets have less pre-trade transparency and, as observed in the CEPR (2006) study, it is difficult to imagine increasing their pre-trade transparency without changing the fundamental structure of the market. An investor must call each dealer in a market to establish a quote. She may not be able to find any dealers willing to provide quotes on both sides of the market, and will therefore have little information about the quality of the quotes she receives. She will, however, know the identity of the market participant taking the other side of the transaction.

Based on interviews with market participants, CEPR (2006) and FSA (2006) report that dealers in Europe and the U.K. respectively believe there is good pre-trade transparency for dealers through inter-dealer quote mechanisms and quote publishing ability. But Bessembinder and Maxwell (2008) state, "Dealer quotations in corporate bonds are not disseminated broadly or continuously. Quotations are generally available only to institutional traders, mainly in response to phone requests. Prior to the introduction of TRACE, transaction prices were not reported except to the parties involved in a trade. In contrast, most stock markets disseminate best quotations and information about unexecuted limit orders to the investing public on a continuous basis, and publicly report prices and quantities for completed trades within seconds of the transaction."

Post-trade transparency concerns the reporting and dissemination of trades after they occur, and can be implemented without fundamentally changing the way transactions occur. For instance, an order-driven exchange may choose to disseminate transaction information or not. Likewise, in a dealer market, a regulator may force participants to disclose trade information to a central authority, and then that regulator may choose what information to disseminate.

The TRACE program in the U.S. is a good example of a regulation designed to improve post-trade transparency. Under TRACE, registered dealers are required to report their transactions to FINRA. FINRA then disseminates price and size information in TRACE-eligible securities[7] after a 15-minute delay (though it does not disseminate the identity of the transacting parties). The time delay before disseminating a trade is itself a popular topic in post-trade transparency (Spatt 2006). TRACE originally disseminated trades at the end of each day, and has gradually reduced the delay to its present 15 minutes.

3. Theories Regarding the Effect of Transparency on Liquidity

There are arguments for and against increased transparency. Transparency may improve liquidity for several reasons. If investors are more confident that they know the right price, they may be more willing to trade. Investors may also be more confident in their broker if they know they can capably asses their broker by comparing her prices against a larger number of data points. Transparency also allows brokers to better compete with each other by examining each other's prices (Stoll 2003).

Conversely, transparency could have an adverse affect on liquidity. On a limit order book, an informed trader may be reluctant to place a limit order because it may convey information to uninformed traders. An informed trader risks the price moving against the order she submits (Stoll 2003). A trader who submits a limit order also risks the limit order being "picked off" if it is offered at too generous a price, or if she fails to respond quickly to news that results in a movement in price. This is sometimes called the "free-option" phenomenon, since limit-order submitters essentially write a free option to other investors to trade at the price of the limit order.[8]

In 2006, the Center for Economic Policy Research (CEPR) put forward a theoretical model for analyzing the effect of increased post-trade transparency on a dealer-driven market. They focus on the "winner's curse"–the phenomenon whereby an uninformed dealer offers a more favorable quote than an informed dealer, thereby making a less profitable trade. Assuming there are multiple dealers who incur information-acquisition costs and therefore have heterogeneous information allocation, CEPR researchers find that increased post-trade transparency will decrease the risk to dealers of offering quotes that are too favorable, and therefore suffering a "winner's curse." Since uninformed dealers in the transparent market have a lower likelihood of suffering a winner's curse, they will compete more aggressively and spreads will be lower. CEPR notes, however, that the overall effect on information revelation is ambiguous.

In contrast, dealers contend that an increase in post-trade transparency will decrease liquidity on a dealer market (Spatt 2006). They believe that if information about trades is disseminated soon after the trade occurs, it will be hard for a dealer who has just taken a position through a large trade to "work out" the trade–that is, sell or buy the units such that their inventory remains at an appropriate level–without moving the price. Dealers will then be reluctant to enter into large trades in the first place, reducing overall liquidity. CEPR (2006) also note that transparency may reduce the willingness of market participants to spend money acquiring information. This could decrease the speed or efficiency of price-revelation on the market.

Regarding trader anonymity, dealers may wish to reveal their identity if they want to build their reputation. However, if a dealer is worried that the price will move against her if participants know she has a deal to unwind, she will be less likely to take a position, decreasing liquidity (Stoll 2003 and CEPR 2006). Institutions may prefer to remain anonymous if they are informed, because they do not wish to move the price against themselves by declaring their interest to trade. If informed investors, including institutions, cannot capitalize on their information, total information revelation will be harmed (Stoll 2003).

4. Measuring Liquidity

Liquidity is the ease at which an investor can trade units of a security. This has three components: price, size, and speed. If the price of executing a transaction for a large number of units immediately is small, then the security is said to be liquid. If, conversely, a participant must wait to execute the desired transaction, or pay a higher price for the same number of units, than the security is illiquid. Some measures are only useful for capturing the price dimension of liquidity, while others incorporate size as well (Tenikue 2004).

There is a growing body of literature that examines the properties of electronic limit order books. A key component of this research involves assessing liquidity for differently sized transactions by examining liquidity at quotes below the best bid and asks, also called examining liquidity "down the book." This line of inquiry is important since investors may need to trade at sizes that exceed the size of the best inside buy and sell quotes. Out of 201,311 orders that caused a transaction immediately when submitted on the TASE corporate bond market in January 2010, 61,900 gave rise to more than one transaction immediately because they exceeded the depth of the relevant inside quote. Benston et al. (2000) put forward a measure for examining the cost an investor faces for trading a certain currency size immediately, called the Cost of Round Trip CRT(D) and use it to analyze equities on the Toronto Stock Exchange, focusing on the information contribution of their measure for investors. Gomber et al. (2004) use a similar measure to analyze equities on Xetra, a German exchange, and track the properties of the liquidity measure around transactions and news events. Kang and Yeo (2008) examine liquidity on the NYSE limit order book, but rather than focus on the costs that investors face, they examine how liquidity affects the placement of quotes on the limit order book. Tenikue (2004) provides a survey of liquidity measures using a sample of stocks from Euronext.

Liquidity measures are also distinguished as being *ex-ante* or *ex-post*. Ex-ante measures provide an indicator of the ease of trade *before* a trade takes place. In contrast, an "ex-post" measure of liquidity provides an indication of how liquid a security was when a transaction took place (Tenikue 2004, Benston et al. 2000).

Tenikue notes that ex-ante measures are useful to investors, since they indicate the cost to immediately execute a trade, while ex-post measures may be useful for analyzing broker execution and by researchers seeking to describe the characteristics of the market. Ex-post measures, unfortunately, only measure liquidity during a transaction, and transactions themselves appear to have some effect on liquidity (Gomber et al. 2004), suggesting that they are less useful as liquidity measures. Gomber et al. also note that investors appear to wait until times of high liquidity, suggesting that ex-ante measures will fail to fully capture the cost of immediacy (2004).

The most commonly used measure for determining ex-ante liquidity is the quoted inside spread (QIS), defined as the ask price minus the bid price, divided by the mid-point price.

This is a normalized indicator of the actual cost to an investor of simultaneously purchasing and selling a security. However, this measure is only computable when there are both outstanding ask and bid quotes.

$$A = Best\ Ask\ and\ B = Best\ Bid$$

$$QIS = \frac{A - B}{P_m}$$

$$P_m = \frac{B + A}{2}\ the\ midprice$$

Effective Spread (ES) is the most popular measure of ex-post liquidity. Effective spread has several estimations. In markets where quotes are available, the effective spread is typically measured as twice the difference of the absolute value of the price of the transaction and the average of the best ask and bid, which is then normalized by dividing by the transaction price.

$$ES = \frac{2\left|P_t - P_m\right|}{P_t} \; : \; P_t = Transaction\ Price$$

For many bond markets, however, there are no available quotes from which to infer a mid-point price. In this case, recent studies have employed a method called the Dealer Round Trip (DRT) (Goldstein et al. 2007; FSA 2006). The dealer round-trip seeks to produce an estimate with the same intuition as the effective spread. In order to construct the DRT, researchers look for instances in which a given dealer purchases and then quickly sells the same (or a slightly smaller) quantity of a given security. Goldstein et al. (2000) and the FSA (2006) employ both a one-day and a five-day threshold for the dealer to sell the security. The difference in price is divided by the average of the two prices.

The DRT, unfortunately, has some disadvantages. First, spreads are frequently negative. In a sample of 3,409 one-day DRTs in recently issued large corporate bonds from the FSA, the median was zero and the 25th percentile was -.03. This is difficult to interpret from a liquidity standpoint; for example, in a sample-wide average including observations with negative spreads, the negative spreads are implicitly assumed to *decrease* illiquidity. Second, as the FSA (2006) notes, a dealer may make a large purchase and then sell it in small lots (2006). If the lots are too small, it may not be considered a dealer round trip. If we expect these small sales to be at less favorable prices than a comparable larger sale (which, as noted above, would be consistent with spread estimates on dealer markets), then there is a bias toward added liquidity.

The quoted inside spread captures the price, but not the size dimension, of liquidity. In order to measure ex-ante liquidity while incorporating the size component, researchers look at several measures.

The quoted inside depth (QID) is the sum of the best bid and ask quote sizes. Benston et al. (2000) take QID together with QIS as a measure of liquidity at the best quote. Intuitively, given that security A and security B have the same QIS, if security A has a larger QID, it is more liquid than security B.

In order to look down the book, Benston et al. propose a measure called the Cost of Round Trip, or CRT(D). This measure attempts to measure the ex-ante cost of trading a specific currency amount of a security. Intuitively, the measure can be described as the cost of simultaneously buying and selling N(D) shares, where N(D) is the specific currency amount D divided by the midpoint price. The CRT(D) is computed for a number of transaction sizes, and reflects the cost to immediately transact at that size. Benston et al. (2000) define the CRT(D) as follows:

Denoting the zero-indexed i^t bid and ask price and quantity by bid_i: $\{P_{-i}, Q_{-i}\}$; ask_i: $\{P_i, Q_i\}$ (e.g., the best bid price is P_{-0} and ask price is P_0), the number of shares corresponding to the currency amount **D** is

$$T(D) = \frac{2D}{P_{-0} + P_0}{}'$$

and specifying two indicator variables, I_{-k} and I_k for sell and buy order of **D** currency, which takes on the percentage amount of the zero-indexed k^t quote that would be satisfied given transaction size $T(D)$ [i.e., 1 for quotes fully satisfied, 0 for quotes not satisfied at all, and a value between 0 and 1 for the last quote satisfied, representing the percentage of that quote that was satisfied].

$$I_{-k} = \begin{cases} 1 & \text{if } T(D) > \sum_{i=-0,-k} Q_i \\ \left(T(D) - \sum_{i=-0,-k+1} Q_i\right)/Q_{-k} & \text{else if } T(D) > \sum_{i=-0,-k+1} Q_i \\ 0 & \text{else.} \end{cases}$$

And,

$$I_k = \begin{cases} 1 & \text{if } T(D) > \sum_{i=0,k} Q_i \\ \left(T(D) - \sum_{i=0,k} Q_i\right)/Q_{-k} & \text{else if } T(D) > \sum_{i=0,k-1} Q_i \\ 0 & \text{else.} \end{cases}$$

The CRT(D) is then specified as

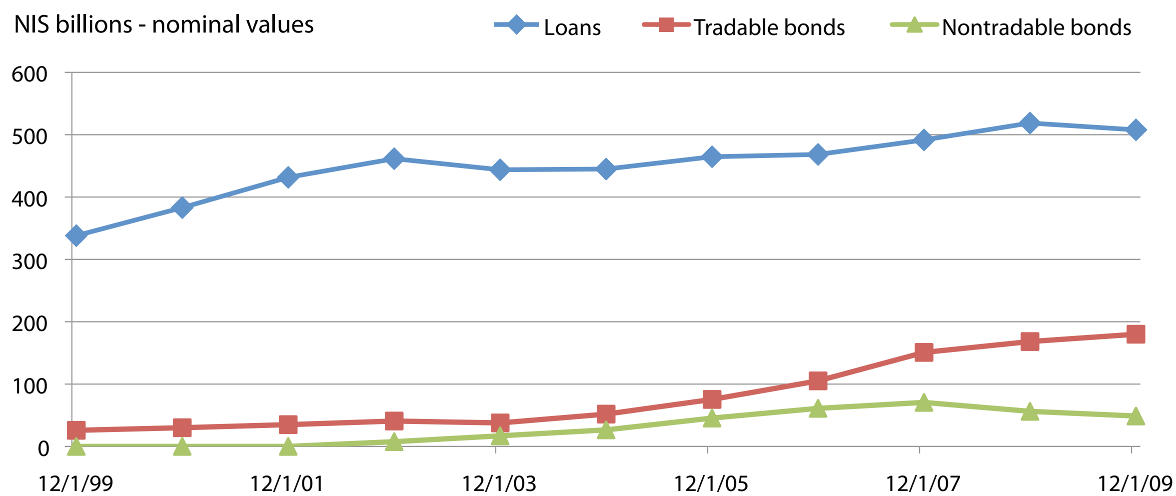
$$CRT(D) = \left(\sum_{k=0,\infty} I_k P_k Q_k - \sum_{k=0,\infty} I_{-k} P_{-k} Q_{-k} \right) / D$$

Kang and Yeo (2008) put forward a similar measurement, which they call the "Cost-to-Trade." Gomber et al. (2004) analyze the properties of another similar measure, called the "Exchange Liquidity Measure," which is calculated by Deutsche Borse AG.

5. Israeli Corporate Bond Market Empirical Overview

As of year-end 2009, the face value of outstanding nonfinancial, tradable Israeli corporate bonds was US$53 billion, or 29 percent of Israel's GDP for that year–roughly the same proportion as in the U.S. and France, less than Korea (45 percent of GDP), and more than Greece (15 percent).[9] Tradable corporate bonds in Israel have been growing at a faster rate than bank loans and nontradable bonds. The face value of nonfinancial tradable corporate bonds in Israel was NIS 26 billion at the end of 1999. That number was 180 billion NIS in 2009–a seven-fold increase. Over that same period, the outstanding debt from bank loans to nonfinancial firms increased from NIS 338 billion to NIS 508 billion.

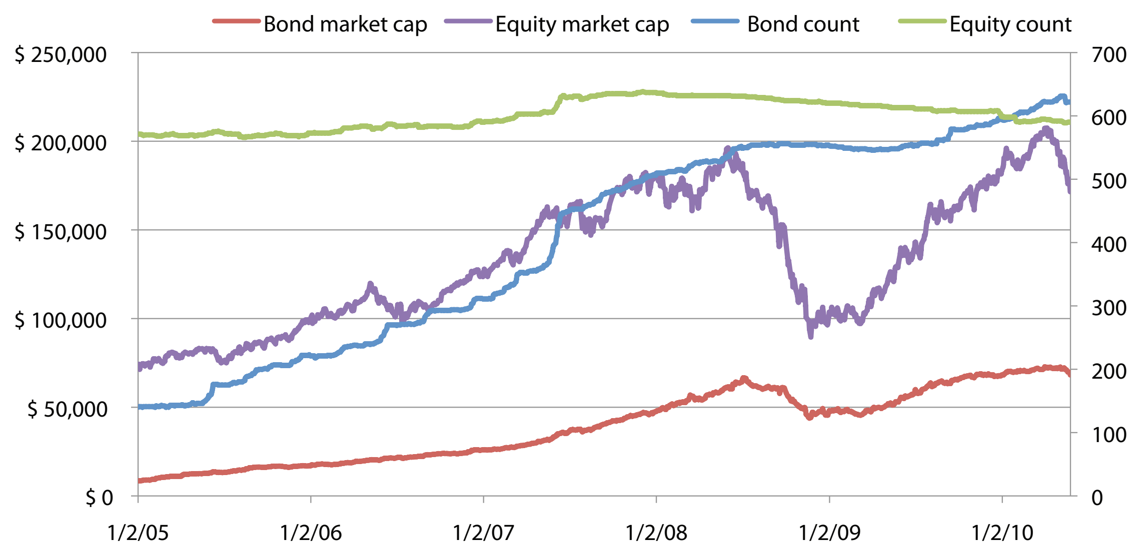
Figure 1. Israeli corporate debt outstanding (nonfinancial)



Note: End of December estimates.

The markets for both Israeli equities and corporate bonds have grown substantially over the last five years, although the world of tradable Israeli bonds is still considerably smaller than the equity equivalent. The market capitalization of Israeli corporate bonds has expanded from approximately US$8 billion at the beginning of 2005 to US$70 billion in May 2010.[10] The bond market lost about 20 percent of its value peak-to-trough during the crisis, but has since entirely regained the loss.

Figure 2. Market cap and count for TASE-listed bonds and equities

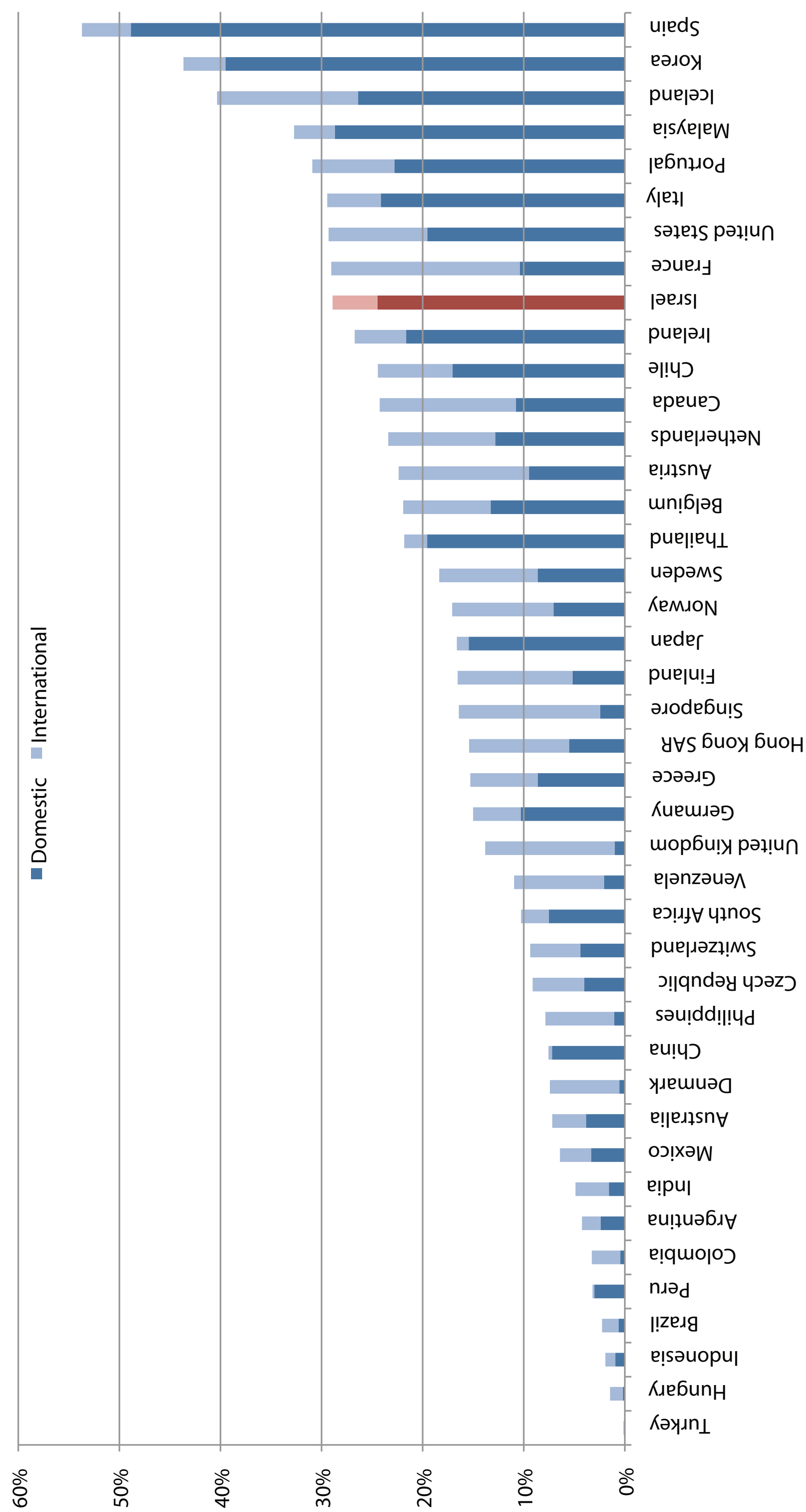


The number of corporate bond series in existence has also expanded dramatically (see Appendix 3). At the beginning of 2005, there were 140 bond series trading on the TASE. That number had expanded to 622 by May 2010. By contrast, the number
of equities traded on the TASE has remained relatively stable, hovering around 600 over the last five years.

International corporate bond markets are vast. Bessembinder and Maxwell (2008) report that the outstanding principal in U.S. corporate bonds at the end of 2006 was $5.37 trillion. They indicate that this figure exceeds U.S. Treasury and municipal bond obligations. They also observe that in each year between 1996 and 2006 (the last year of their study), U.S. bond issuance was considerably larger than U.S. equity issuance.

As shown in figure 3 on the following page, Israeli domestic corporate bond debt was a large portion of Israel's GDP relative to other countries. Some countries, particularly in Europe, have more international corporate bond debt.[11]

Figure 3. Outstanding Nonfinancial Corporate Bond Debt as % of GDP, 2009



Sources: International bond statistics from BIS, Israeli bond statistics from Bank of Israel and BIS, GDP statistics from IMF.

5.1 Volume and Transaction Frequency

Corporate bonds in Israel can trade both on the TASE and OTC; volume on the TASE is considerably higher than volume OTC. In 2009, the average day saw volume of approximately NIS 647 million on the TASE and NIS 45 million OTC. The aggregate market turnovers over that period were 0.28 percent and 0.02 percent over that same period.

Table 1. TASE-listed corporate bond volume and turnover

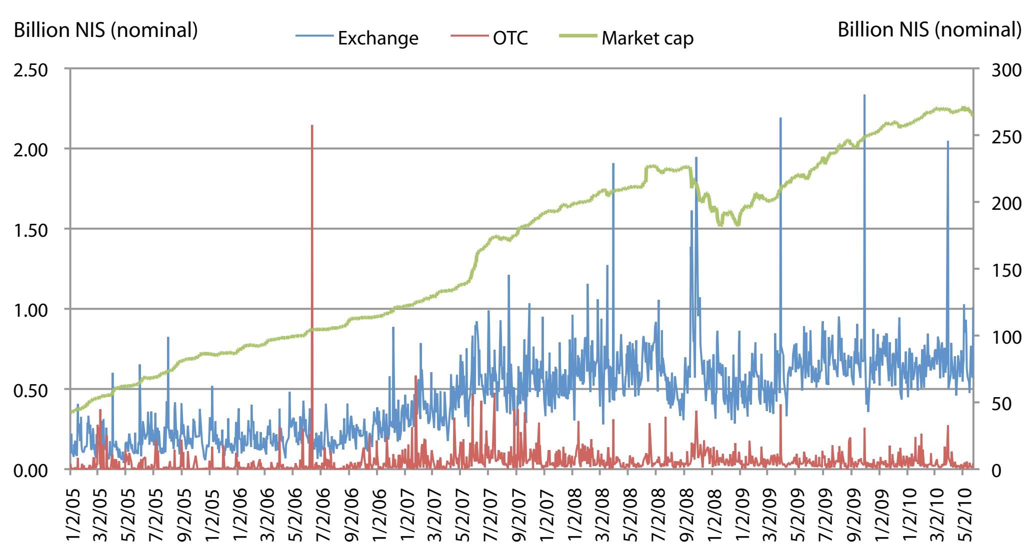
Daily averages by year

	Average bond turnover		Volume (NIS mil)		Bond market turnover		Market cap (NIS mil)	Count
Year	Exchange	OTC	Exchange	OTC	Exchange	OTC		
2005	0.22%	0.02%	185	24	0.28%	0.04%	68,469	173
2006	0.18%	0.02%	225	34	0.21%	0.03%	104,846	263
2007	0.25%	0.02%	512	73	0.32%	0.05%	160,667	419
2008	0.26%	0.03%	639	60	0.31%	0.03%	208,231	539
2009	0.27%	0.03%	647	45	0.28%	0.02%	229,793	562
2010	0.28%	0.02%	682	41	0.26%	0.02%	266,345	612

Notes: Market cap is in April 2010 US$ millions and is not free float-adjusted. Counts are of bond and equity series.

In January 2010, mean security-day volume on the TASE was NIS 1.08 million; the corresponding OTC volume was NIS 101,000. OTC volume is very skewed; of the 12,223 security-days in the month of January, only 696 saw an OTC transaction. In contrast, 10,592 security-days on the TASE had at least one transaction. OTC volume accounted for only 8.6 percent of total corporate bond volume during the month of January.

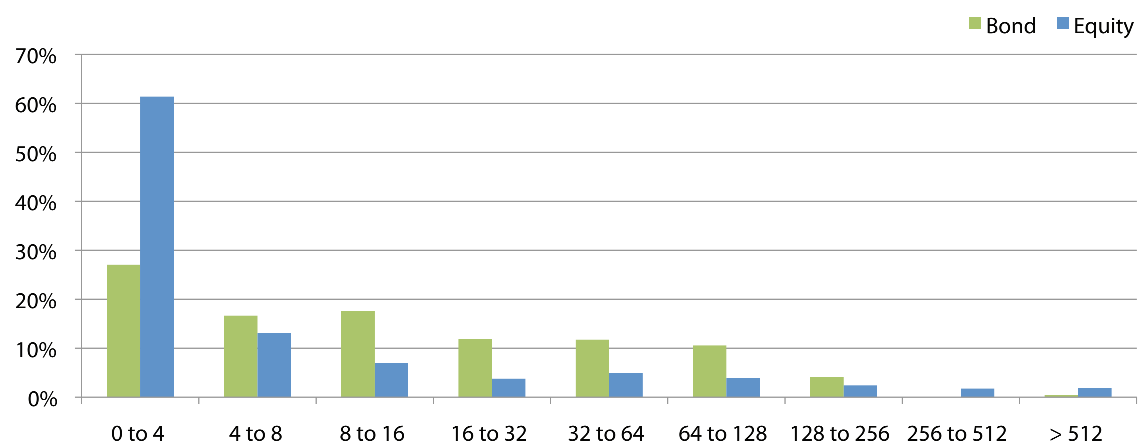
Figure 4. Aggregate market volume



Notes: Outlier 13/6/06 was caused by the buy-back and reissuance of a large bond series. Volume on left axis, market capitalization on right axis.

High transaction frequency is commonly regarded in economics as a societal boon, implying larger surplus profit and more effective price revelation. Israel enjoys high bond trading frequency. Between January 2009 and May 2010, the median bond series averaged 10.4 trades per day on the exchange and the mean averaged 32.0 trades per day.

FIGURE 5. DAILY TASE TRANSACTIONS COUNT
JANUARY 2009-MAY 2010

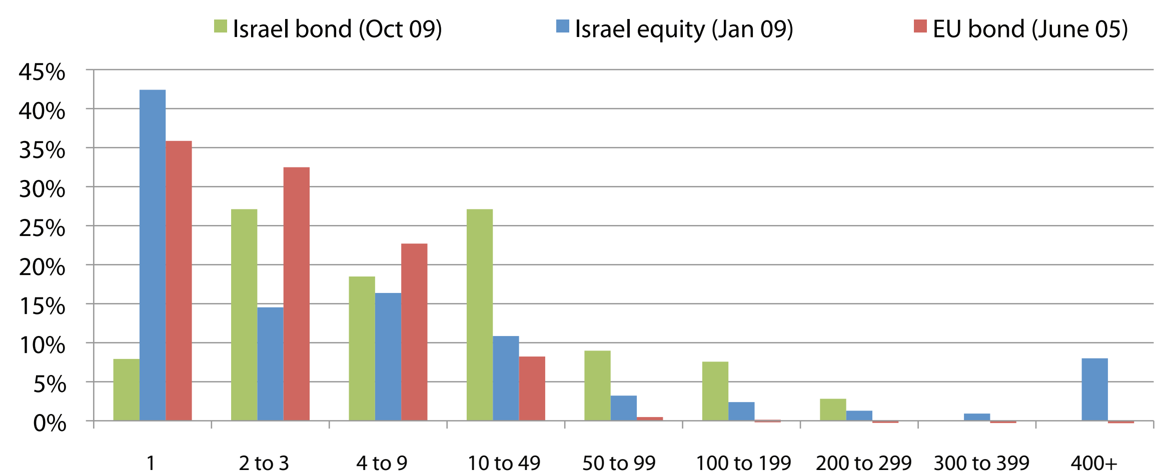


Note: Daily averages by security (for instance, 60% of equities averaged between 0 and 4 trades each day over the sample period).

The Israeli bond market has more cross-sectional transaction count dispersion than the Israeli stock market. Between January 2009 and May 2010, only 27 percent of bond issues averaged less than four trades per day; 61 percent of equities averaged four or fewer trades over the same period.

Bonds on the TASE trade much more frequently than bonds in the U.S., British, and European markets. The FSA (2005) reports that for a representative day in June 2005, in a database (ICMA TRAX) of more than 200,000 EU-listed bond issues, only 5,273 (or slightly more than 2.5 percent) traded that day. By contrast, the average day on the TASE saw at least one transaction in 81.3 percent of bonds available for trading (SD = 3.9 percent). Bonds on the Israeli market also witness more transactions on days in which they trade, relative to EU trade counts.

Figure 6. Representative day transactions count by series



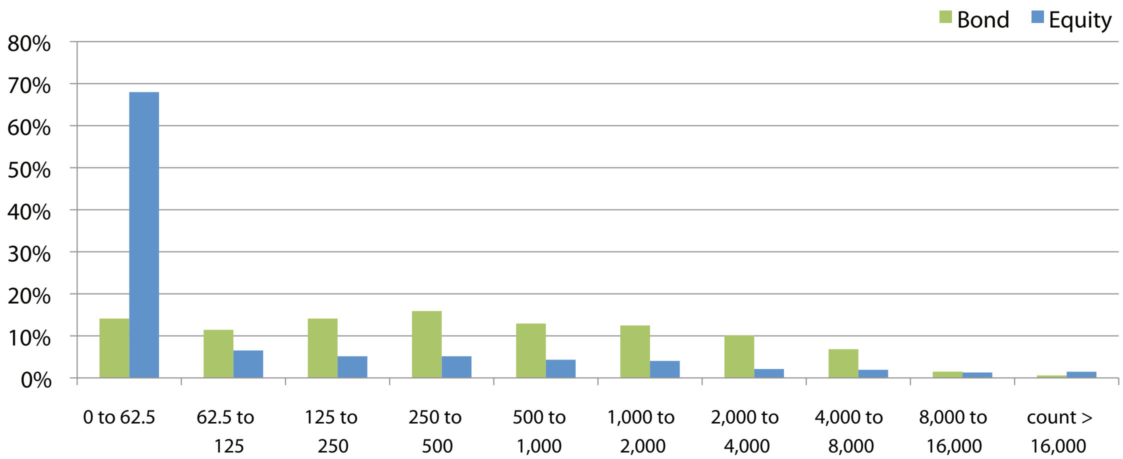
Note: Transactions are counted for bonds with *at least* one transaction on the day. For instance, on the Israel bond representative day, 7% of series with a transaction had one transaction.

CEPR, using a smaller data set of around 800 euro-denominated and 600 sterling-denominated corporate bonds, finds that euro-denominated corporate bonds averaged slightly more than three trades per day and sterling bonds averaged about two trades per day (2006).[12] Biais and Declerck (2007) estimate that euro-denominated bonds trade on average four times per day, while sterling bonds trade on average 1.5 times per day.

Both the European and Israeli figures compare favorably against the U.S. market. In a sample of 120 U.S. BBB-rated corporate bonds tracked from July 2002 to February 2003, Goldstein et al. find that median average trade frequency is 1.4 trades per day and for a given bond, there are on average 15 days between trades (2007).

Volume of bond trading on the Israeli market is also more dispersed than volume on the equity market. The median bond issue averaged NIS 400,000 daily; the mean across all bond issues was NIS 1.36 million daily. For Israeli equities, those figures are NIS 22,000 and NIS 1.15 million, respectively.

FIGURE 7. AVERAGE DAILY VOLUME ON THE TASE BY ISSUE
JANUARY 2009 - MAY 2010, NIS THOUSANDS



Note: Average volumes by security - for instance, 67% of equities had an average daily volume between 0 and 62.5 thousand NIS over the sample period.

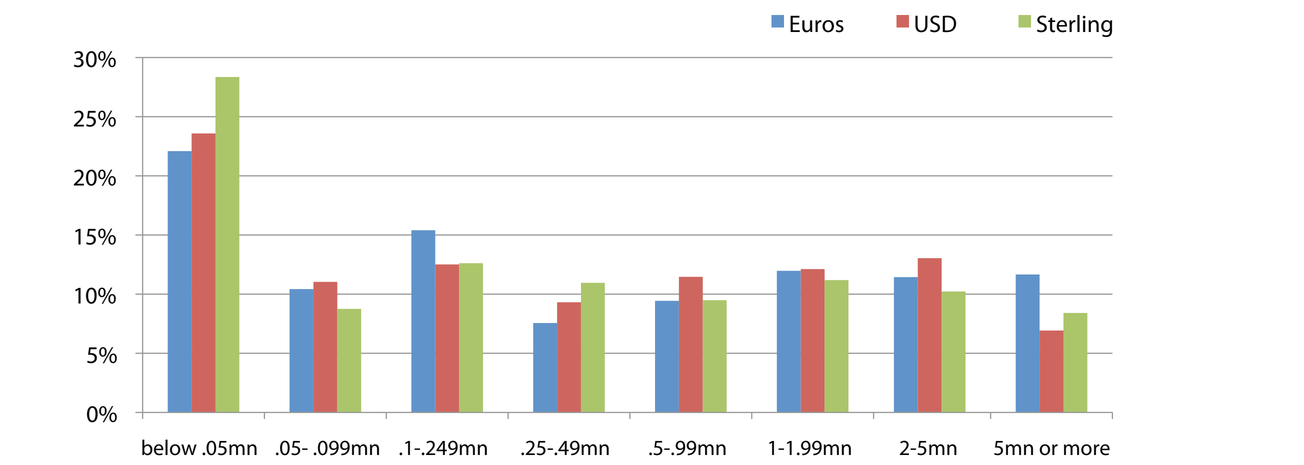
The general presumption for bond trading is that the volume is highly concentrated in newly issued bonds, while seasoned bonds receive much less volume (FSA 2006). Given the classical assumption that trading volume is largely related to the release of new information (Lo et al. 2004), this observation is consistent with the general intuition that information affecting bond prices of equal magnitude to information affecting stock prices is released on average less frequently.

5.2 Trade Sizes

Trade size is often viewed as function of the transparency and structure of the market, and as an indication of the market participants. Larger average trade size suggests higher participation by institutional investors relative to retail investors. Larger trade size may also suggest an unwillingness or incapability of trading in small lots. If investors are capable of negotiating better prices by trading in higher quantities, liquidity may be increasing in trade size. Researchers in Europe and the U.S. observe liquidity increasing with trade size (see Spatt 2006; Goldstein et al. 2007; Bessembinder et al. 2005; Edwards et al. 2005; CEPR 2006).

Bonds markets in the U.S., U.K., and Europe are characterized by large trade sizes. The FSA reports that EU average corporate bond trade sizes are between €1 and €2 million (2005). CEPR reports that the average transaction size for euro-denominated bonds was around €1 million, while the average transaction size for sterling-denominated bonds was £800,000.

Figure 8. Trade size in European corporate bond markets
Representative day, June 2009



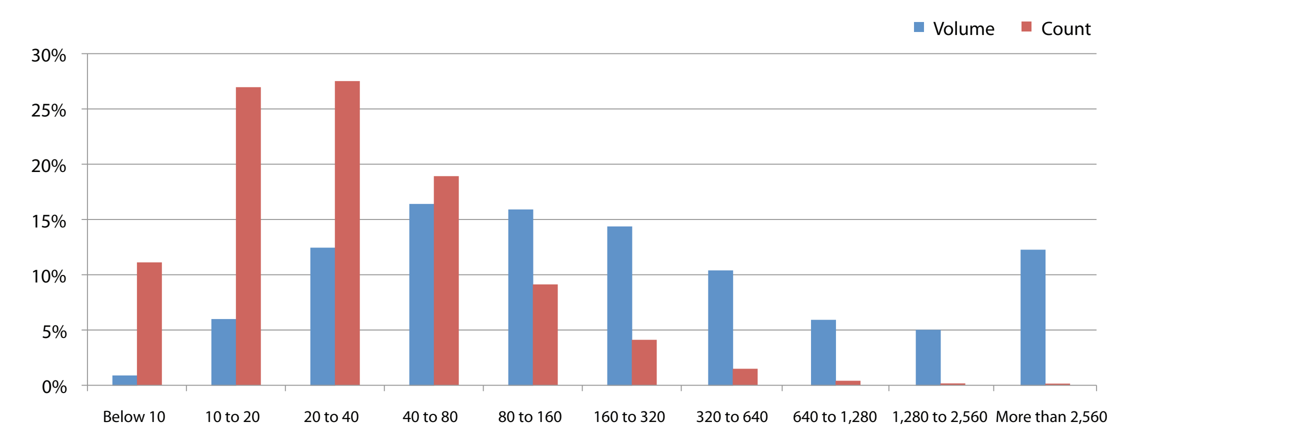
Source: FSA.

In the U.S. market, Bessembinder and Maxwell report that during 2006, 85.6 percent of corporate bond trading volume occurred in trade sizes of at least $1 million, while 96.7 percent of volume occurred in trade sizes of at least $100,000.

By contrast, trade sizes in Israel are much smaller.[13] Between January 2009 and May 2010, the mean corporate bond trade size on the TASE was NIS 68,871 (SD of NIS 259,998). The median was only NIS 26,788.

Trade size is heavily skewed in count and bi-modal in volume. Trades between NIS 10,000 and 20,000 accounted for almost 26 percent of all trades, but less than 6 percent of trade volume. Trades larger than NIS 2.56 million accounted for about .10 percent of trades but more than 12 percent of trade volume.

Figure 9. Trade size distribution in Israel
January 2009 - May 2010, NIS Thousands



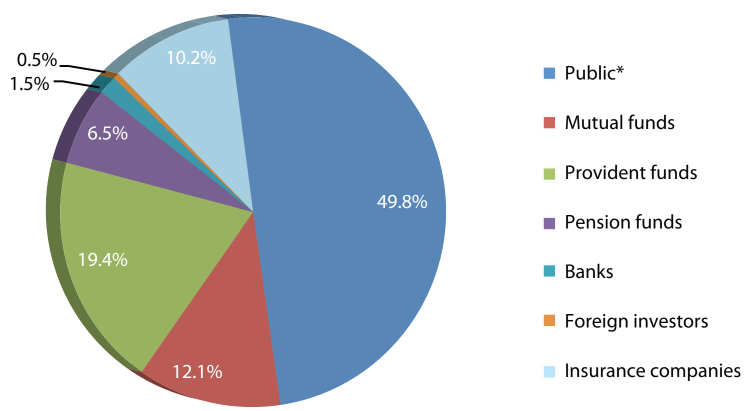
Note: Orders that walk down the book are considered a single transaction. Distribution across all transactions (for instance, transactions below NIS 10,000 accounted for 1% of all volume and 11% of all transactions during the period).

The distribution of trade sizes can have important policy implications. A measure that increases liquidity for small trades and decreases liquidity for large trades by the same factor may adversely affect aggregate market liquidity, merely by virtue of the relative volumes of large and small trade sizes as a fraction of total market volume. Distribution of trade size can also have policy implications related to investor segmentation, as a policy may affect different classes of investors differently.

5.3 Investor Composition

As one would expect in a market characterized by a large number of small trades, a relatively large proportion of Israeli corporate bonds is held by the public. According to Bank of Israel statistics, approximately 50 percent of corporate bonds are held by the public at large in 2010.[14] This is not the case in Europe and the U.S., where Bessembinder and Maxwell (2008) and CEPR (2006) report that bonds are largely held by pension funds and insurance companies.

FIGURE 10. ISRAELI CORPORATE BOND INVESTORS
2010 HOLDINGS BY MARKET CAP



Source: Bank of Israel.
*Public includes private individuals and companies; may include holdings by subsidiaries of debt issuer

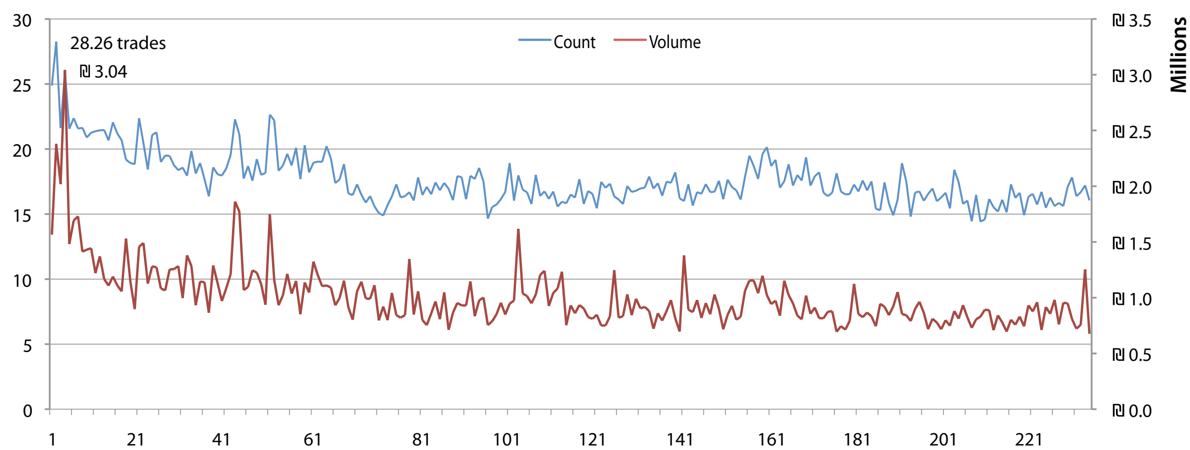
In the U.S. and Europe, bond trading is concentrated in new issues (FSA 2006). Bessembinder and Maxwell (2008) and CEPR (2006) report that bonds generally get absorbed into the stable "buy-and-hold" portfolios of pension funds and insurance companies soon after issue. The general belief is that corporate bonds are less sensitive to news that impacts price, and therefore more appealing as a holding in stable, infrequently modified portfolios.

We test to see if Israeli corporate bonds have a similar initial burst of trading followed by a subsequent drop-off in interest. In order to determine the new bond issues, we look at a complete listing of price histor on the TASE and take those bonds with no data before February 2006, verifying that these bonds have no observed transactions before that time.

While Israeli corporate bonds do have an initial burst of activity followed by a drop-off in liquidity, it is not as great as the drop-off reported in foreign markets. This suggests that, unlike elsewhere, bond investors in Israel do not generally employ a "buy-and-hold" strategy but rather respond to new information long after initial issuance. This difference in investor strategy may be a cause or effect of the liquidity: Investors elsewhere may prefer to trade more frequently, but are prevented by low liquidity; or investors elsewhere may buy and hold, thus reducing total transactions thereby reducing overall liquidity.

We also observe that trading volume drops off more steeply than transaction count. This suggests that average order size decreases over time. This is consistent with the intuition that some portion of the bond series gets absorbed into stable institutional portfolios, while another portion is traded by non-buy-and-hold investors at smaller trade sizes.

Figure 11. Trading in new Israeli bonds
2006-2010



Note: Average volume and transaction count of bond series by days since issuance.

6. Liquidity Measurements

We perform a detailed analysis of liquidity on the TASE limit order book for corporate bonds for the month of January 2010, with some complementary analysis of corporate bonds in March 2009 and equities in January 2010. We find that the quoted inside spread was lower for corporate bonds in January 2010 (median security's mean over the period = 96 bps) than for equities in the same period (309 bps) or corporate bonds in March 2009 (263 bps). Effective spreads are substantially lower than quoted spreads, at 11.45 bps, 12.65 bps, and 13.50 bps for transaction medians, respectively. Consistent with the trends seen in foreign corporate bond markets, effective spreads decrease with trade size.

See Appendix 4 for a detailed set of liquidity measurements.

6.1 January 2010 Sample Description

To create our January 2010 bond sample, we recreate the limit order book for every security for every point in time on the exchange to the nearest centi-second, synthesizing all of the transactions and verifying our transactions against an independent dataset of transactions on the TASE. Of the 12,080 bond-days with a valid order book, we have identified nine bond-days during which our transactions did not match the provided transactions and eliminated them from the sample.

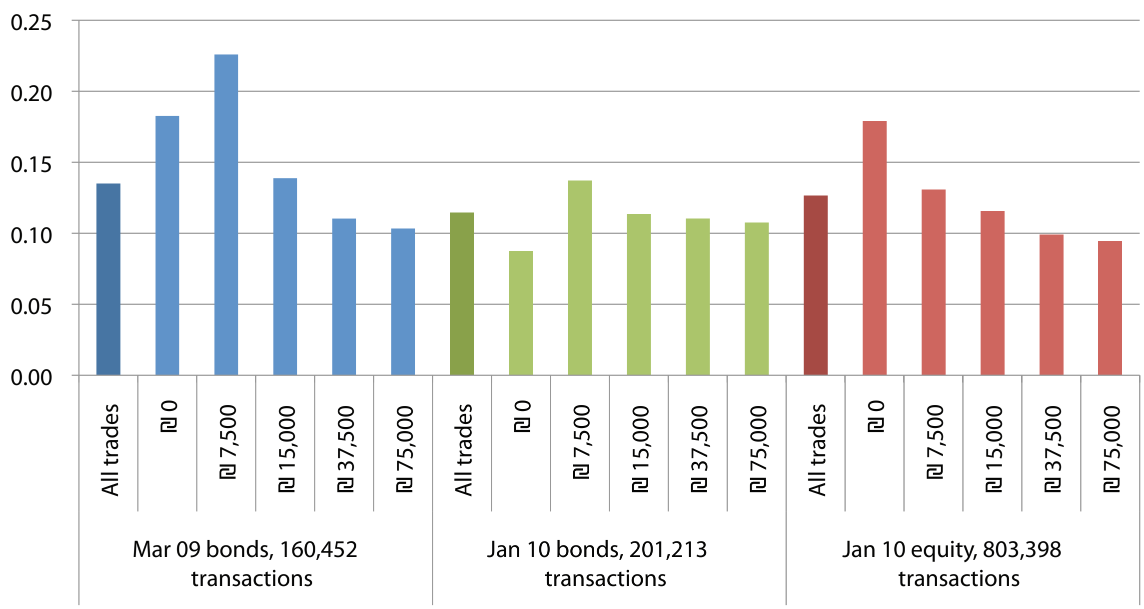
The TASE has an opening call auction at or before 8:30am for all bonds, followed by continuous trading until 4:15pm. The trading day is then concluded with another call auction. We also synthesize the opening auction and closing auction and verify that those transactions match the transactions records provided.

We take the entire population of corporate bonds that traded on the TASE through the entire January 2010 period. In this month, there were 21 trading days and 591 bonds available for trading on at least some of those days. We filter out 13 bond series that listed for fewer than 15 days that month, leaving a sample of 578 bonds and a total of 12,080 bond-days of trading. Finally we eliminate from the sample all bond-days in which either the buy side or sell side of the book was completely empty for more than 10 percent of the trading day, and all bond-days for which we were unable to successfully reconstruct the book, leaving a sample of 11,492 bond-days. This has the unfortunate effect of biasing the sample towards added liquidity. Any liquidity measure that relies on top bid and ask quotes cannot be computed if one side of the book is empty. In constructing average daily liquidity measures, we ignore periods during which one side of the book is empty, taking instead the last available data before the empty book. We employ the same rules for determining our March 2009 bond and January 2010 equity samples.

6.2 Ex-Post Liquidity: Effective Spreads

Effective spreads capture past liquidity (Benston et al. 2000). Although Benston et al. (2000) and Tenikue (2004) note that effective spreads are not predictors of future liquidity, both papers also note that they can be used by researchers to assess market quality. FSA (2006), CEPR (2006), Biais and Declerck, and Goldstein et al. (2007) each use effective spread or dealer round-trip (a method of calculating the cost of the trade when no firm reference quotes exist) to assess market quality.

Figure 12. Median effective spreads by trade size (.01 = 1 basis point)



Note: We take bonds that are issued between February 2006 and March 2010. We produce average transaction counts and volumes since issuance. This graph is NOT logarithmic. Volume appears to drop off more steeply than count, indicating that average order siz

Effective spreads for corporate bonds were highest in the NIS 7,500 to 15,000 trade size interval; they generally decrease with trade size. Effective spreads were highest in our March 2009 corporate bond sample, though we note that there is considerably less variation among effective spreads than among our ex-ante measures.

We also note that our observed effective spreads on the TASE are in the ballpark of effective spreads or dealer-round-trip calculations reported in foreign markets. CEPR's (2006) figures for mean effective half-spreads on the European markets are shown in the table below:

Table 2. European corporate bond effective spreads

CEPR reported mean effective half (.01 = 1 bp) by year and currency denomination

Year	2003	2004	2005
Euro-denominated	0.1478	0.073	0.1024
Sterling-denominated	0.3884	0.2152	0.2078

Consistent with CEPR (2006), FSA (2006), Biais and Declerk (2007), and Goldstein et al. (2007), we find that effective spreads decrease with trade size. We do note that at the highest trade size intervals, spreads once again appear to increase (see Appendix 5, figure 22).

These findings, taken in conjunction with our observation that CRT(D) increases in trade size, could be consistent with Gomber et al.'s (2004) finding that investors wait for high liquidity before making a large transaction.[15] They could also be consistent with our own results that ex-ante liquidity measures are better able to predict larger transactions than smaller transactions (see section 6.6). Alternatively, trades may be occurring in highly liquid securities in larger quantities at a disproportionately high rate. Transactions themselves are more likely to appear during times of high liquidity or in highly liquid securities. This introduces a bias since transactions themselves are evidence of high liquidity. Taking effective spread on a per security basis dramatically increases effective spread measurements in our sample.

Table 3. Effective spreads by security (.01 = 1 basis point)

Trade Sizes (NIS thousands)	All	Below 10	80 to 160	1,280 to 2,560
March 2009 bonds				
Mean spread	1.73	1.90	1.72	1.07
Std. dev. spread	5.48	4.98	6.11	2.30
Avg. # transactions*	47.08	34.95	38.80	2.80
Std. dev. transactions*	129.30	62.15	93.42	3.79
# of transacting securities	523	500	435	102
January 2010 bonds				
Mean spread	0.60	0.63	0.59	0.28
Std. dev. spread	1.41	1.41	0.94	0.37
Avg. # transactions*	48.77	35.24	33.42	2.53
Std. dev. transactions*	102.95	46.41	51.71	2.49
# of transacting securities	581	562	529	145
January 2010 equities				
Mean spread	1.81	2.27	1.44	0.97
Std. dev spread	2.50	2.65	1.99	2.50
Avg. # transactions*	305.01	704.53	143.03	4.27
Std. dev. transactions*	906.59	1299.63	574.42	9.15
# of transacting securities	492	490	292	73

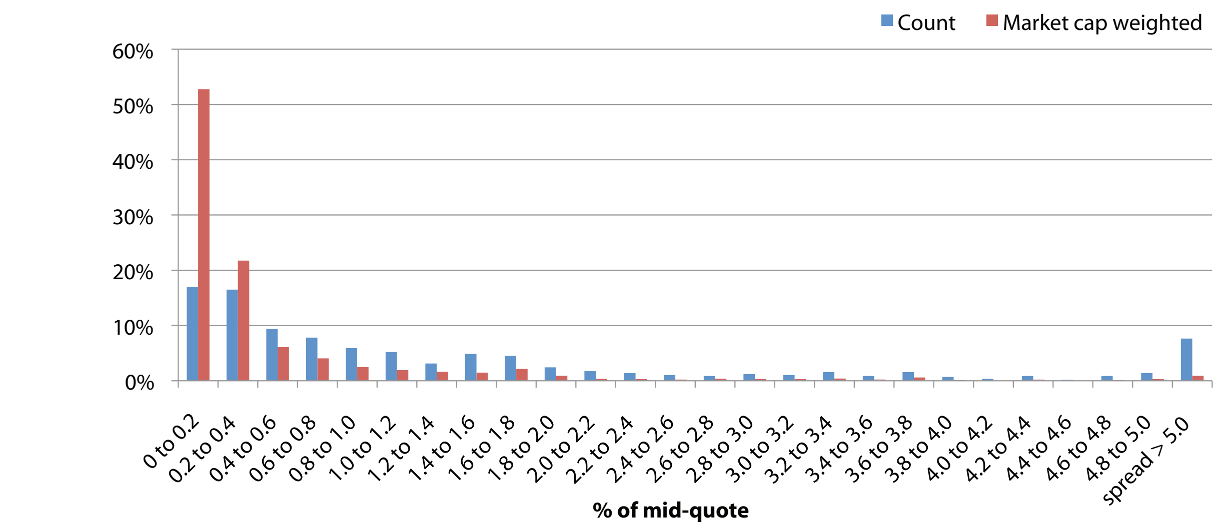
**Transacting securities only*

Mean and standard deviation of the number of transactions in the given transaction size for each security and the average effective spread for transactions in the given transaction size for each security.

6.3 Ex-Ante Liquidity: Quoted Inside Spread and CRT(D)

The median bond over the sample period had a median inside spread of 0.96 percent of the mid-quote. The distribution of median spreads is skewed, and clusters at tighter spreads.

Figure 13. Median average daily inside spread by bond series January 2010



Note: For instance, bonds with an inside spread between 0 and 20 basis points represented 17% of all bonds but 52% of the market capitalization in the bond market. 576 bonds in the sample.

It appears that a large number of bonds exhibit tight inside spreads; only 10 percent of the bonds exhibit inside spreads of 5 percent or higher.

Benston et al. (2000) put forward a methodology for measuring liquidity on limit order books called the Cost of Round Trip – CRT(D) – which they use to measure liquidity on the Toronto Stock Exchange.[16] The CRT(D) is a method for measuring the cost of trading a given currency value in a particular security at a particular time. The measure is taken at several currency values, and this provides an indication of liquidity down the book.

We take CRT(D) measures at five trade sizes (NIS): 5,000; 10,000; 25,000; 50,000; and 100,000. The five sizes chosen are all "retail" sizes; these trades account for over 90 percent of all trades, and about half of all volume. If trade size exceeds the book on either side, we fix the cost of the excess shares at 50 ticks above (below) the best ask (bid) quotes.[17]

Table 4. CRT(D) excess values

	Percent incomplete books (Book size does not meet specified currency value)					
	March 2009 bonds		January 2010 bonds		January 2010 equities	
	Sell side	Buy side	Sell side	Buy side	Sell side	Buy side
₪ 5,000	0.28	0.27	0.37	0.05	4.27	5.91
₪ 10,000	0.75	1.32	0.58	0.37	8.23	13.79
₪ 25,000	4.69	6.52	5.99	2.94	16.67	27.13
₪ 50,000	11.67	15.47	13.43	8.94	28.36	40.78
₪ 100,000	23.92	30.43	27.69	21.46	44.22	55.99

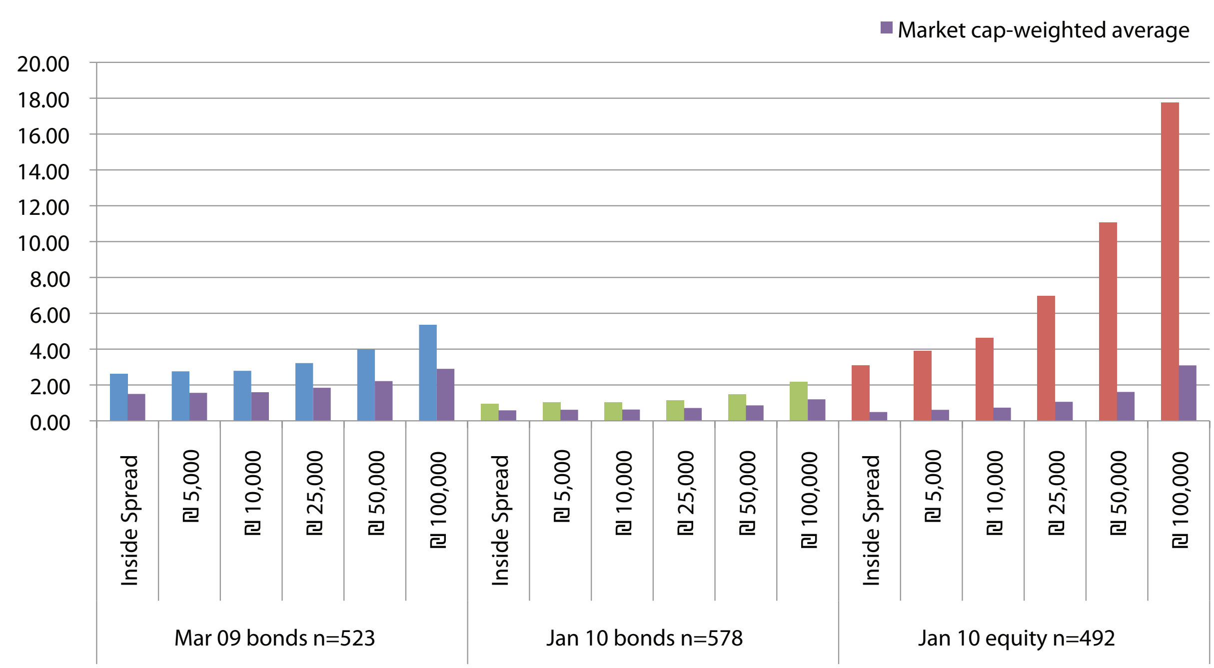
Note: Percent of time that depth of the book failed to exceed a specified currency amount. 4.69 = 4.69% of the time aggregated across all securities in the sample.

When interpreting a book that fails to have adequate depth for a trade size, we contend that there is no clear ex-ante liquidity for a trade at that size. This suggests that liquidity is therefore lower than would be the case if additional orders were made at the worst price available on the book.

Taken by count, there appears to have been considerably less depth on the equities books than on the bond books. Depth for equities in January 2010 failed to exceed NIS 100,000 more than half the time, while for corporate bonds over the same period depth failed to exceed NIS 100,000 only about one fifth of the time. However, this figure is greatly affected by a large number of small, illiquid equities. Depth for equities in January 2010 failed to exceed NIS 100,000 only about 5 percent of the time when adjusted for market capitalization.[18]

Corporate bond liquidity was considerably higher in January 2010 than in March 2009. Ex-ante liquidity was considerably lower for equities than for corporate bonds in January 2010. Directly observing the ex-ante liquidity also reveals less depth on the equities than the corporate bonds. The median CRT(NIS 100,000) for corporate bonds in January 2010 was about twice the amount of the QIS, however the median CRT(NIS 100,000) for equities was about six times the amount of the QIS. It's evident, however, that a considerable portion of the illiquidity comes from a large number of smaller equities. If, rather than taking the median equities' ex-ante measurements, we take the market-cap weighted average, the difference in liquidity between January 2010 bonds and equities falls off sharply.

Figure 14. QIS and CRT(D) by bond series
Medians and market cap-weighted averages



Note: Medians in blue, green, and red; weighted averages in purple. (.01 = 1 basis point)

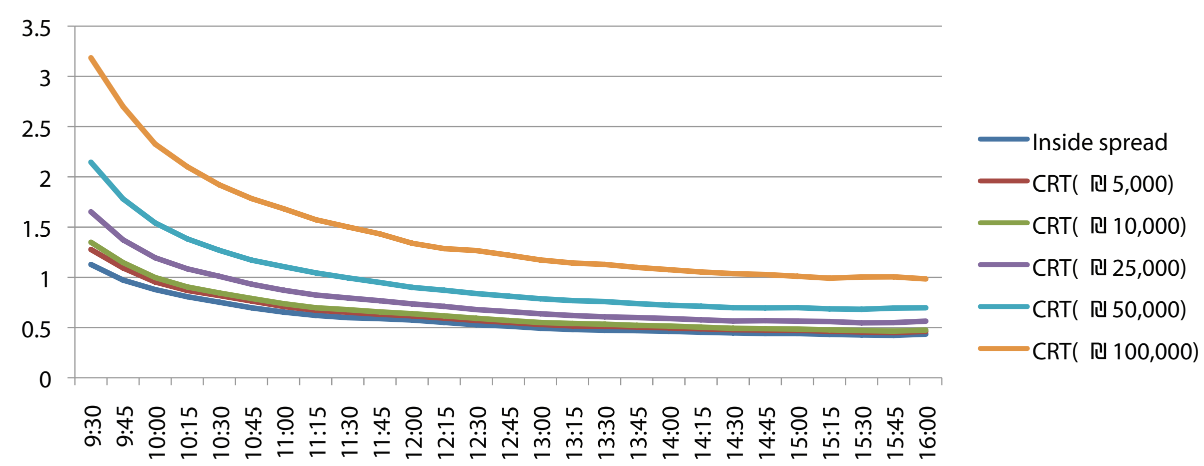
Table 5. Market cap–weighted ex-ante liquidity measures

	March 09 bonds			January 10 bonds			January 10 equity		
		% incomplete book			% incomplete book			% incomplete book	
QIS	1.50	Sell	Buy	0.58	Sell	Buy	0.49	Sell	Buy
₪ 5,000	1.56	0.07%	0.09%	0.62	0.05%	0.01%	0.61	0.24%	0.33%
₪ 10,000	1.60	0.18%	0.44%	0.63	0.10%	0.07%	0.74	0.51%	0.78%
₪ 25,000	1.84	1.27%	1.75%	0.72	1.55%	0.78%	1.06	1.08%	1.64%
₪ 50,000	2.22	3.08%	4.10%	0.86	3.75%	2.51%	1.61	2.20%	3.00%
₪ 100,000	2.90	6.80%	9.21%	1.20	9.26%	7.42%	3.09	4.33%	5.26%

Note: For ex-ante liquidity measures .01 = 1 basis point. For incomplete books, .07% indicates that the book failed to exceed the depth .07% of the time based on market-cap weights for each security.

Liquidity on the limit order book (LOB) fluctuates throughout the day. We find that inside spread and CRT measures in our sample are decreasing throughout the day. This is consistent with observations of the Toronto Stock Exchange from Benston et al. (2000).

Figure 15. Median liquidity measures by time interval (.01 = 1 basis point)



Note: Time-weighted average liquidity measures for the median bond in the sample in the given time interval are 15 minutes long.

6.4 Liquidity and Yield

Spreads must represent a small fraction of expected return in order for trades to occur; otherwise the value from new information may not outweigh the costs of trading on that information (Chen et al. 2005; Lo et al. 2004). For corporate bonds, yield can function as expected return. If corporate bond spreads are large, we expect there to be fewer bond transactions.

From an investor standpoint, illiquidity reduces total expected return by acting as an exogenous cost. An investor may believe that a particular investment will have an expected return of five percent, but if the cost of the transaction is 100 basis points, she cannot credibly believe the expected return to still be five percent. In both March 2009 and January 2010, transaction costs would have reduced the expected return of a corporate bond substantially. In March 2009, an investor who wanted to purchase NIS 10,000 worth of bonds at in the middle decile of corporate bonds by yield would have observed a before-spread average yield to maturity (YTM) of 10.42 percent, but after including the cost of the transaction (and not even including taxes or fees), they would have obtained an average YTM of 7.50 percent. If we take YTM as a proxy for expected return, this represents a 28 percent decrease in total expected return due to transaction costs.

We also observe that during March 2009, a period of high average bond yields, transaction costs were a higher relative percentage of bond yields than in January 2010. For example, bonds in the middle decile by yield in March 2009 had an average yield 2.27 times higher than bonds in the middle decile in January 2010. After including CRT(D) at NIS 100,000, the March 2009 middle decile average yield was only 1.58 times higher than the January 2010 middle decile average yield.

Table 6, on the following page, shows average bond yields by yield deciles, before and after liquidity costs. For example, bonds in March 2009 in the third decile by yield had an average yield of 5.41 percent, but after subtracting the inside spread, their average yield was reduced to 3.60 percent. For a transaction of NIS 100,000, the yield was further reduced to 2.57 percent.

Table 6. Bond yields after liquidity costs

	Yield deciles	Yield	Inside spread	CRT(₪ 5,000)	CRT(₪ 10,000)	CRT(₪ 25,000)	CRT(₪ 50,000)	CRT(₪ 100,000)
Mar 09	1st	1.51	1.07	1.06	1.05	1.01	0.95	0.80
	2nd	3.84	3.23	3.21	3.20	3.13	3.04	2.86
	3rd	5.41	3.60	3.53	3.51	3.42	3.19	2.57
	4th	7.61	5.29	5.18	5.07	4.43	3.97	2.75
	5th	10.42	7.64	7.50	7.44	6.58	5.69	4.05
	6th	14.75	9.97	9.83	9.63	8.75	6.65	4.10
	7th	21.13	14.42	14.20	14.10	12.16	9.54	5.55
	8th	31.60	17.85	17.20	16.83	15.09	11.66	7.00
	9th	49.29	31.08	30.09	29.71	26.50	21.83	14.21
Jan 10	1st	0.72	-0.16	-0.18	-0.18	-0.23	-0.36	-0.64
	2nd	2.37	1.59	1.57	1.56	1.48	1.36	1.05
	3rd	3.06	2.02	1.96	1.94	1.82	1.62	1.19
	4th	3.83	2.66	2.6	2.58	2.48	2.32	1.92
	5th	4.59	3.47	3.42	3.4	3.26	3.02	2.55
	6th	5.43	4.28	4.18	4.17	4.03	3.83	3.27
	7th	6.53	5.24	5.16	5.14	5	4.74	4.15
	8th	9.33	7.53	7.42	7.36	7.04	6.48	5.41
	9th	17.76	15.84	15.65	15.57	15.15	14.29	12.49

Source: Israel Securities Authority, Economics Dept.

6.5 Usefulness of the CRT(D)

In order to assess the usefulness of CRT(D) for investors, Benston et al. posit that an ex-ante measure of liquidity should be able to predict subsequent transaction frequency (2000). They test to see if CRT(D) and QIS measures, taken at hourly intervals throughout the day, can predict transaction frequency in the subsequent hour. They also test to see if CRT(D) is a stronger predictor of transaction frequency at higher trade sizes than QIS for transactions at the same trade size.

Benston et al. find that the CRT(D) contributes additional information to investors relative to quoted inside spread. Using a Poisson regression,[19] they compare the goodness of fit of CRT(D) on transaction count to the goodness of fit of QIS and QID on transaction count. In both cases, they take the ex-ante liquidity measure at the beginning of each hour of trading and then tally transactions over the course of the hour. They test the measure for CRT(D) at five trade sizes, using the corresponding transaction count at each size, and conclude that CRT(D) has better goodness of fit than QIS at larger transaction sizes.

We replicate this procedure on the TASE limit order book for corporate bonds during January 2010, with several differences. Rather than take snapshots of the book, we estimate ex-ante liquidity measures over the five minutes immediately preceding the hour, taking the time-weighted average of the measurements to the nearest one-hundredth of a second. We believe this approach is less likely to capture temporary spikes or drops in the measurements. We also choose more retail trade-sizes, which we believe is appropriate given the large proportion of retail trades on the TASE.

For the entire sample of corporate bonds, CRT(D) and QIS can are related to transaction frequency. (See Appendix 6 for results.) We find pseudo r-squared[20] measurements for CRT(D) range from 5.59 percent (for trade size 0 to NIS 7,500) to 19.06 percent (NIS 75,000 and higher). QIS regression pseudo r-squared measurements are similar. Goodness of fit is lower for the two lowest trade size intervals than for the three higher intervals. It's possible that investors who trade in larger quantities are more aware of or care more about transaction costs than investors who deal in smaller trade sizes.

Parameter estimates for CRT(D) and QIS are all significant and negative. This indicates that more liquid periods are related to subsequent trading activity. CRT(D) estimates range from -.4853 (0 to NIS 7,500) to -1.0612 (37,500 to NIS 75,000), indicating that an increase in CRT(D) of 1 percent may decrease transaction frequency by .48 to 1.06 percent.

Goodness of fit results for CRT(D) in our sample are slightly lower than corresponding QIS results for the lower three trade sizes, and slightly higher for the later two trade sizes. The differences are considerably smaller than those in the Toronto equities market. We are unable to conclude that CRT(D) provides additional information for corporate bond market investors in January 2010.

6.6 Ex-Ante Liquidity and Efficiency on the Bond and Equities Markets

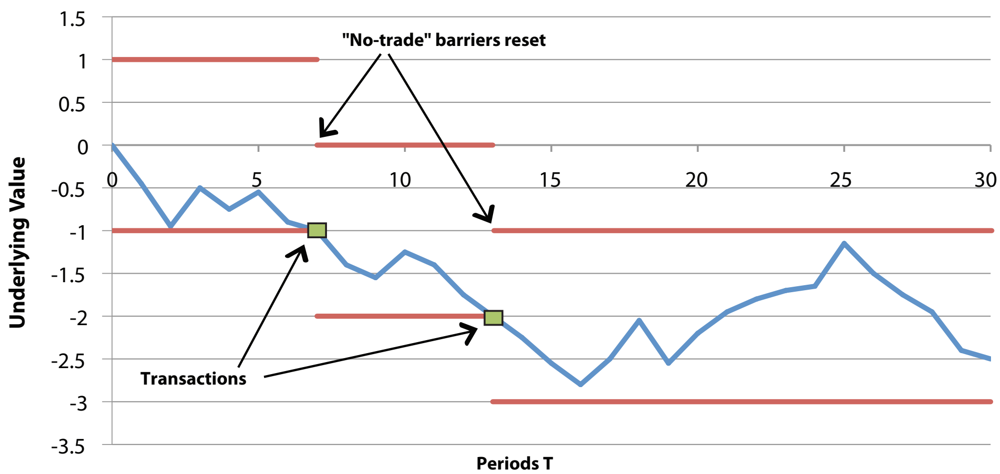
We are also interested to know whether the added information contribution of CRT(D) found by Benston et al. is applicable to equities but not to bonds. If QIS or CRT(D) appears to have predictive power for equities but not for a matched set of bonds, this could suggest that CRT(D) contributes additional information to investors for equities (Benston et al. perform tests only on equities).

In order to test this, we take a sample of equities for companies that also have at least one bond series listed in the Tel Bond 60.[21] There were 26 companies (see Appendix 7 for the list) with tradable equities that also had at least one bond in the Tel Bond 60 (these 26 companies together had 39 bond series listed in the Tel Bond 60). Testing bonds and equities issued by the same company allows us to test the difference in effects of CRT(D) on transaction frequency for two different types of claims on the *same asset*. We perform the same regression separately for the sample of equities and the corresponding sample of bonds, employing in these cases a 15-minute interval rather than an hour-long interval (see Appendix 6, panel 2, for results). We find that for the equities, CRT(D) does contribute added information at higher transaction sizes (pseudo r-squared values of 27% for CRT(D) against 17% for QIS at the largest trade sizes). However, for the bonds, CRT(D) does not contribute added information (pseudo r-squared values of 4.5% for CRT(D) against 5.3% for QIS at the largest trade sizes). Both the equity sample and the bond sample are composed of highly liquid securities. If securities are highly liquid, ex-ante measures should have less ability to predict subsequent transactions since we expect supply and demand shocks to be unrelated to liquidity.

The greater predictive ability of CRT(D) in the equities sample, both relative to QIS and in absolute terms, may be considered evidence that our equities sample absorbs information less efficiently than the matched bond sample. This argument follows the reasoning that in equilibrium transactions should only occur after information shocks or liquidity shocks that arrive randomly. Therefore relatively greater ability to predict transaction frequency with ex-ante liquidity measures suggests that the entire effect of the shock isn't being absorbed immediately. Transactions are then predictable as the effect of the shock is worked into the market. There is some evidence in the U.S. high-yield market that for matched bonds and equities, the equities are not more efficient at absorbing price impact than bonds, and that following earnings announcements bonds appear to price-correct from forecast error faster than equities (Hotchkiss and Ronen 2002).

However, an alternative and possibly stronger explanation for our results could be that equities are more sensitive to changes in the underlying asset value than bonds. Supposing that bonds and equities only trade when there is a shift in their value large enough to surmount transaction costs, there are then "no-trade" zones in which the value of the underlying asset may shift but there will not be a transaction (Lo et al. 2004). In figure 16 below, the value of the security is represented in blue. When a transaction occurs, the security's "no-trade" barriers shift to reflect the new realized value.

Figure 16. Stylized "no-trade" zones



Note: The value of the security is represented in blue. When a transaction occurs the security's "no-trade" barriers shift to reflect the new realized value.

Making also the realistic assumption that for a given bond and equity pair from the same issuer, the equity will be more sensitive to changes in the value of the issuer, we expect there to be a greater frequency of tradable opportunities for the equity than for the bond. Our test can only sense a relationship in those instances where it is possible for a trade to occur. Larger trade sizes serve to widen the "no-trade" barrier, since the CRT(D) is increasing in trade size. Therefore the increased predictive power of the test at the larger trade sizes may reflect the greater sensitivity of the equities to changes in the underlying asset value relative to the matched bonds. If this is the case, it may explain some of the difference in our equity and bond results, since the value of the underlying could be deviating from that value at the time of the last bond transaction, but the bond is not sensitive enough for the value to exceed the no-trade zone, curtailing the possibility of a transaction. Whereas the matched equity at the same time may be sensitive enough that a transaction is possible. Therefore if we observe a divergence in the predictive power of the model at this time it is not necessarily that the bond is "more efficient," merely that the "inefficiency" goes unrealized, and hence unobserved.

Table 7. Pseudo r-squared values

Matching bonds and equity from Tel Bond 60				
	Bonds (n=39)		Equity (n=27)	
NIS interval	CRT(D)	QIS + QID	CRT(D)	QIS + QID
₪ 0 to ₪ 7,500	0.51%	1.49%	4.63%	4.86%
₪ 7,500 to ₪ 15,000	0.89%	0.76%	15.89%	13.31%
₪ 15,000 to ₪ 37,500	3.21%	2.92%	21.80%	15.85%
₪ 37,500 to ₪ 75,000	3.89%	3.66%	25.39%	16.79%
₪ 75,000 and up	4.49%	5.29%	27.41%	17.17%

Note: Pseudo r-squared from Poisson regressions of the ex-ante measure or trade frequency in the subsequent period within the specified trade size range. Periods are 15 minutes. All parameter estimates for the ex-ante measures are significant.

We find that both ex-ante measures appear to have better fit when examining smaller bonds or the entire bond market than when examining our matched Tel Bond 60 sample. The matched Tel Bond 60 sample is more liquid and this may account for the lower ability for the model to predict transaction frequency.

Table 8. Pseudo r-squared values for large bond samples

	All Bonds		All Bonds Except Tel Bond 60	
NIS Interval	CRT(D)	QIS + QID	CRT(D)	QIS + QID
₪ 0 to ₪ 7,500	5.59%	8.17%	3.48%	5.60%
₪ 7,500 to ₪ 15,000	11.10%	11.34%	7.51%	7.69%
₪ 15,000 to ₪ 37,500	17.47%	17.50%	12.57%	12.72%
₪ 37,500 to ₪ 75,000	18.40%	17.40%	13.99%	13.29%
₪ 75,000 and up	19.06%	16.53%	15.32%	13.22%

Note: Pseudo r-squared from Poisson regressions of the time-weighted average ex-ante measure for five minutes on the subsequent hour's trade frequency within the specified trade size range. All parameter estimates for the ex-ante measures are significant.

7. Conclusion

We undertake a broad empirical analysis of liquidity on the TASE corporate bond market. Using orders and transactions data provided by TASE, we are able to reconstruct the limit order book for a large sample of corporate bonds and equities, and also to compute liquidity measures—the CRT(D)—which examine liquidity "down-the-book." Employing CRT(D), we observe that ex-ante trade costs increase with trade size, while using same sample effective spreads, we determine that ex-post trade costs decrease with trade size. We believe these results taken together may be consistent with the research of Gomber et al., who suggest that large trades are "timed."

Observed effective spreads on the TASE during our sample are similar to ex-post liquidity measurements in the U.S. and Europe, in spite of their very different market structures and transparency regimes. We also compare TASE corporate bonds to TASE equities and confirm that equities exhibit the same liquidity measure to trade size relationships. TASE equities appear to have had slightly lower liquidity than TASE bonds over the January 2010 sample.

Observed liquidity is lower in our higher-yield sample period relative to our lower-yield sample period. We believe this is consistent with research by Chen et al. and Lo et al. Deducting average trading costs from yield decreases yield dramatically in both our March 2009 and January 2010 samples.

We employ the methodology put forward in Benston et al. to examine the possibility that CRT(D) contributes additional information about subsequent transaction frequency relative to quoted inside spread. We find that for a sample of equities, CRT(D) does have an added information contribution. However, we fail to find evidence of an added information contribution in a matching set of corporate bonds.

The greater predictive ability of CRT(D) in the equities sample, both relative to QIS and in absolute terms, may be considered evidence that the equities market absorbs new information less efficiently than the bond market in a sample of matched companies with large bond issues. Greater predictability of transaction frequency suggests a less efficient market, since transactions should only occur after (unpredictable) information or liquidity shocks. However, greater predictive ability of CRT(D) in the equities sample may instead be consistent with the supposition that trades can only occur if the underlying value of an asset shifts enough to surpass the cost of trading in that asset (Lo et al.). Matching equities and bonds provides us with two goods that are both claims on the underlying asset. In this case we expect the equity claim to be more sensitive to changes in the asset value, and therefore more likely to exceed the "no-trade" barrier. If liquidity has at least some impact on trade frequency (and this is consistent with results from *all* our samples), then the relative frequency of potential trade situations will be higher for the equities and therefore the CRT(D) will have greater predictive ability with the equities.

Currently, traders on the TASE have public access to the top three best bid and ask quotes. Our finding that CRT(D) contributes added information relative to the top bid-ask quotes in the equities suggests that it may be beneficial for market participants to see greater depth on the limit order book.[22]

Given our results, there are several questions for future research:

- All other things being the same, if ex-ante liquidity on U.S. and European corporate bond markets could be measured, would it be similar to TASE ex-ante liquidity measures?
- If U.S. and European corporate bond markets were order-driven, rather than dealer-driven, would ex-post liquidity be different than either current Israeli ex-post liquidity or current same-market ex-post liquidity?
- If Israeli corporate bond markets were dealer-driven, rather than order-driven, would liquidity exhibit different properties, and can we sign the difference?
- Would a change in market structure impact retail and institutional investors differently?

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Appendixes

Appendix 1: Recent Interest in Corporate Bond Market Structure

Trading transparency on the corporate bond markets was a hot topic before the recent financial crisis. On July 1, 2002, the National Association of Securities Dealers[23] (NASD) began the Trade Reporting and Compliance Engine (TRACE) program, a system for reporting transactions in corporate bonds (see SEC release no. 34-47057). TRACE required all NASD members to report prices, quantities, and other information for all secondary market transactions in corporate bonds (see Goldstein et al. 2007 for a detailed description of TRACE requirements). Before TRACE, there was only limited post-trade transparency in the U.S. corporate bond market. The regulatory change was the subject of several studies, including Edwards, Harris, and Piwowar (2004); Goldstein et al. (2007); and Bessembinder, Maxell, and Venkataraman (2005). Edwards et al. and Goldstein et al. find that TRACE increased liquidity for retail size trades, although Edwards et al. estimate the one-way cost reduction from TRACE at only 1 to 4 basis points. Bessembinder et al. find that TRACE reduced transaction costs by 50 percent in TRACE-eligible bonds and by 20 percent in similar non-TRACE eligible bonds. Bessembinder and Maxwell (2008) take the results of the above studies as evidence that TRACE has increased liquidity.

In Europe there was also substantial interest in corporate bond market transparency during the same period. The technical committee of the International Organization of Securities Commissions (IOSCO) released a report in May 2004; the Financial Services Authority (FSA) in the U.K. released a discussion paper in September 2005, and a follow-up in July 2006; and the Centre for Economic Policy Research (CEPR) released a report entitled "European corporate bond markets: Transparency, liquidity, efficiency" in May 2006. Under the Markets in Financial Instruments Directive (MiFID), the European Commission was required to examine non-equity securities market transparency. They delegated that task to the Committee of the European Securities Regulators (CESR), which has released a number of reports, the first in August 2007.[24]

Each of the European reports notes the implementation of TRACE and raises, as a question, the possibility of increasing trade transparency in Europe and England. Both the FSA follow-up (2006) and the original CESR report (2007) conclude that additional regulations to promote transparency are not necessary in their respective jurisdictions. CESR now believes that there should be mandated post-trade transparency for a broad set of corporate bonds and is actively considering pre-trade transparency as well (CESR 2010). Eddy Wymeersch, chairman of CESR, recently identified corporate bond market structure and transparency as an active area for possible regulatory change.[25]

Appendix 2: A Review of Market Structures

Market microstructure theory draws a distinction between two broad categories of market structure, auction markets and dealer markets (Stoll 2003). An auction market is characterized by investors who trade directly with each other. By contrast, investors in a dealer market typically trade with a third party, the dealer, who does not seek to take a position in the trade.

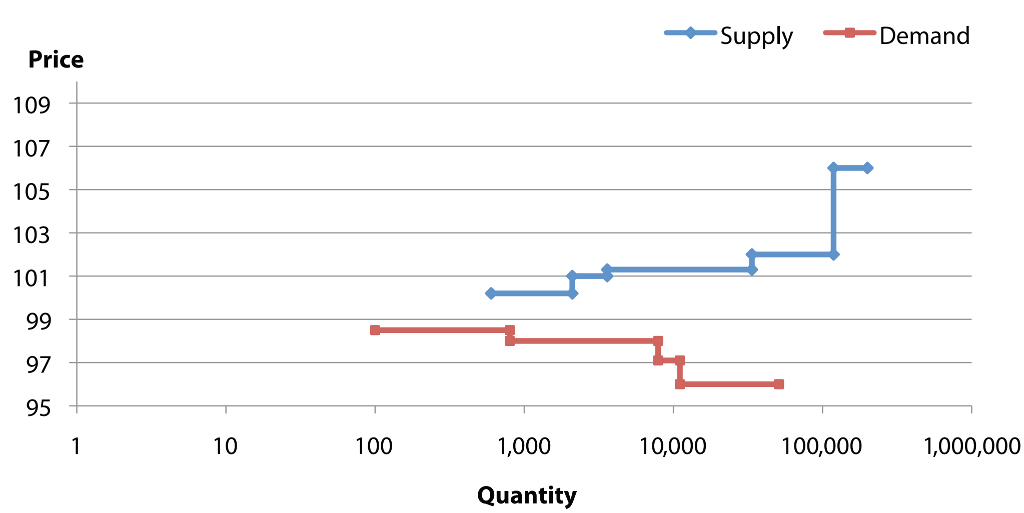
The NYSE, the TASE, and many other exchanges employ a type of auction market called a *continuous auction* during intraday trading. In a continuous auction market, investors make offers to buy (bids) and sell (asks) a fixed amount of shares for a given price. This is called a *limit order*. Limit orders can be submitted both by investors seeking to take a position in the security and by dealers, often called market-makers, who offer both to buy and sell the security and seek to make a profit through imbalances in demand and supply (Stoll 2003). Limit orders are arranged into a *limit order book*, a listing of all the existing bids and asks in the order in which they may trade. On many limit order books, including the TASE, the orders are arranged by price-time priority: Higher priced bids and lower priced asks trade first; for two bids or asks at the same price, the earlier submitted order trades first. A limit order at the top of the book executes when another limit order in the opposite direction is submitted at the same or better price. A limit order also executes when a market order is submitted in the opposite direction. Market orders are orders to buy or sell at any price available, and they transact immediately.

Table 8. Stylized limit order book

Security ABC (quantity in units; price in currency)			
Buy quantity	Buy price	Sell price	Sell quantity
100	98.5	100.2	600
10000	98.5	100.3	1500
950	98.1	100.3	1500
10000	96	100.5	30000
100000	90	106	85000
1	85		

A limit order book can also be considered the displayed aggregate supply and demand curves of a security. In a continuous auction, the curves do not cross and the market price is considered somewhere in between the highest priced bid and lowest priced ask.

Figure 17. Stylized supply and demand chart



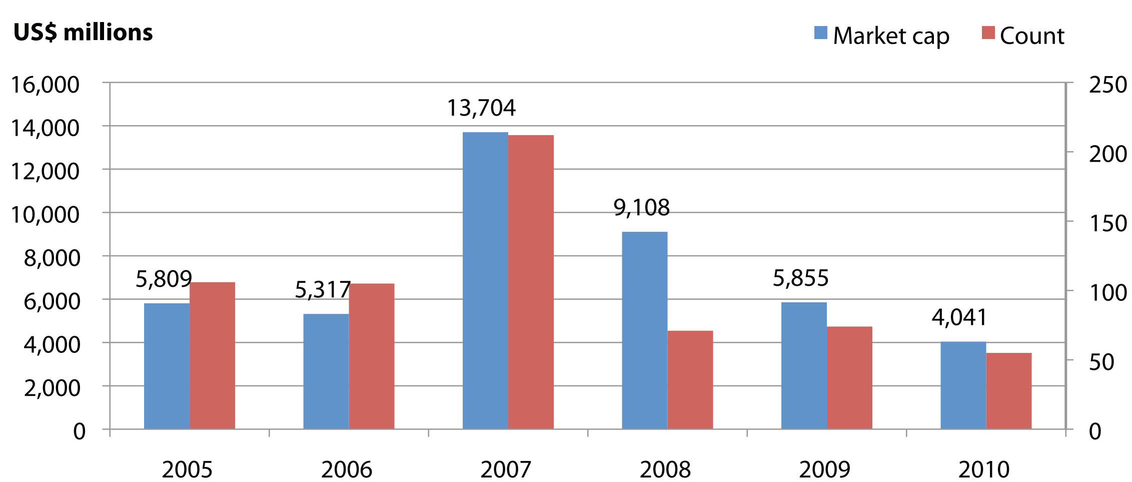
In a dealer market, investors make transactions with a dealer rather than directly with other investors (Stoll 2003). Unlike investors, who seek to make a profit from a position in an investment, dealers seek to profit by providing liquidity. An investor may either call a dealer on the phone or contact a dealer through an electronic communications network (ECN). In either case, the investor my ask the dealer what the price is to buy or sell a given number of units in a security, or the dealer may have published bid and ask quotes at which she is willing to trade. The latter form is properly called market-making (Bessembinder and Maxwell 2008). IOSCO (2004) reports that in SC2 countries, much of the corporate bond market dealing takes place via telephone, but that the popularity of electronic communications networks is increasing. FSA reports likewise for Britain specifically (FSA 2005).

Dealer markets are generally considered decentralized markets. More than one dealer may trade in a particular security, so an investor may go to more than one location (physical or electronic) to determine the best price at which to trade. Pre-1997 NASDAQ[26] provides a good example of a decentralized dealer market (Stoll 2003). On the NASDAQ, investors could contact many physically dispersed dealers to trade in the same security. The FSA, citing an analysis by the International Capital Market Association (ICMA), reports that in England, indicative[27] bid/offer quotes were available in more than 9,400 bond issues in June 2005. Of those issues, "1,100 had ten or more dealers, nearly 1,800 had six to nine dealers, and more than 4,300 had between two and five dealers. About 2,200 had only one dealer." (FSA 2005).

Appendix 3: Issuance Trends

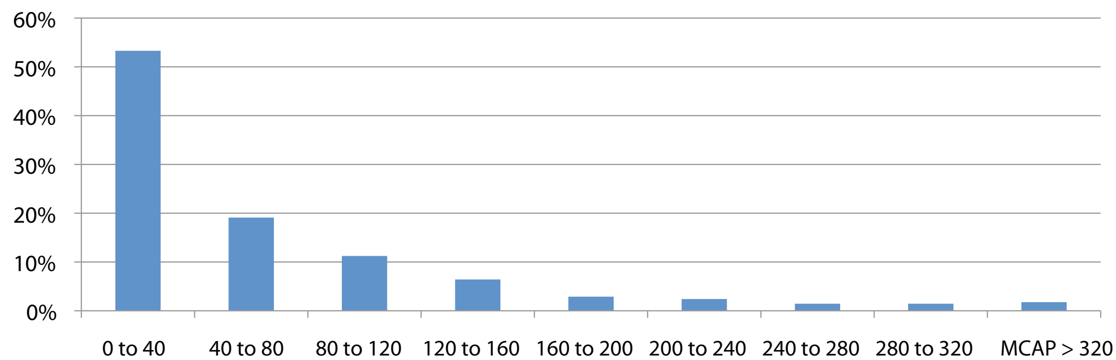
The Israeli corporate bond market experienced a boom in bond issuance during 2007 and 2008, although the 2008 issuance was clustered in fewer but larger total new issues. Bond issuance in 2010 to date has exceeded 2009 levels.

Figure 18. New bond series and re-issues



Note: April 2010 dollars; 2010 figures are from January to May.

Figure 19. Size of new bond series by market cap 2005 - 2010, in April 2010 US$



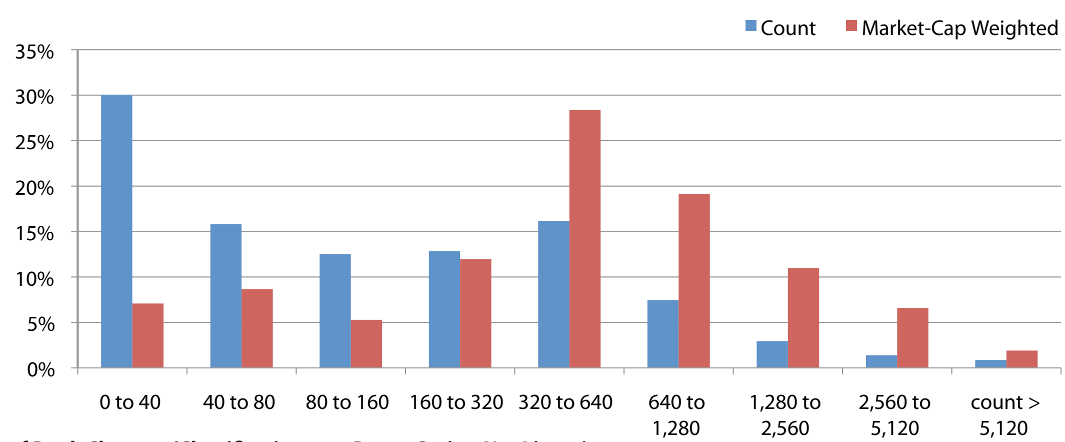
Note: Over 50% of bond series issued over the period were smaller than $40 million. n=623

There were 623 new bond issues or bond re-issues that were listed on the TASE between January 2005 and May 2010. Slightly more than half had a market capitalization of less than US$40 million after one day of trading.

Appendix 4: Limit Order Book Order Submissions and Cancellations

Among the 578 bonds in the sample, the median average daily number of book changes (submission and cancellation of orders) was 98.0. The mean was 350.7. The distribution is heavily skewed, indicating that most of the quote activity is clustered in a few bond series. However, this statistic is somewhat unreliable since some bonds have market makers who continually refresh quotes, thus increasing the total number of distinct book changes without inserting fresh quotes.[28]

Figure 20. Average number of book changes per day By security, January 2010



Count of Book Changes (Classifications are Power Series, Not Linear)

Note: For instance, 30% of securities had between 0 and 40 changes per day, but only 6% of the market capitalization in the bond market had between 0 and 40 book changes per day.

Appendix 5: Liquidity Measurements

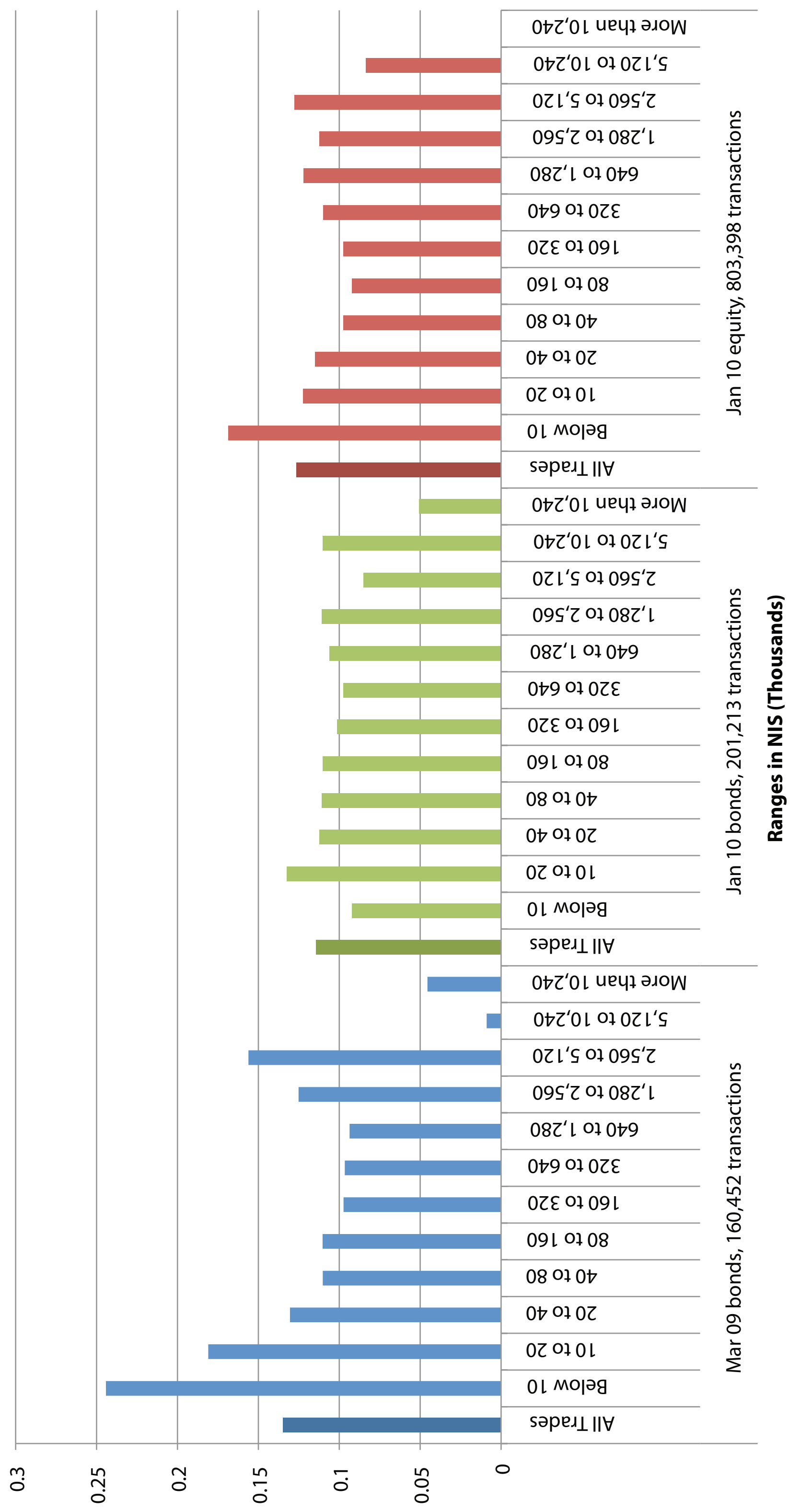
Table 9. Ex-ante spread measurements: QIS and CRT(D)

Mean inside spread and CRT(D) by security percentile (.01 = 1 bp)

Percentiles	Inside spread	CRT at transaction size				
		₪ 5,000	₪ 10,000	₪ 25,000	₪ 50,000	₪ 100,000
March 2009 corporate bonds (n= 523)						
10th	0.28	0.3	0.31	0.33	0.39	0.53
20th	0.68	0.7	0.72	0.79	0.94	1.24
30th	1.08	1.14	1.2	1.35	1.61	2.08
40th	1.75	1.83	1.95	2.24	2.61	3.46
50th	2.63	2.76	2.79	3.22	3.99	5.36
60th	3.98	4.16	4.25	4.89	6.24	8.71
70th	6.18	6.51	6.7	8.49	10.86	13.93
80th	9.33	9.94	10.28	13.09	16.92	23.71
90th	17.1	17.29	18.2	22.24	30.27	45.57
January 2010 corporate bonds (n= 578)						
10th	0.16	0.17	0.17	0.19	0.22	0.32
20th	0.26	0.28	0.29	0.32	0.39	0.62
30th	0.39	0.44	0.45	0.52	0.68	1.01
40th	0.64	0.69	0.71	0.81	1.05	1.61
50th	0.96	1.03	1.04	1.15	1.47	2.18
60th	1.38	1.52	1.57	1.77	2.14	2.95
70th	1.91	2.05	2.11	2.46	2.98	4.09
80th	2.97	3.18	3.2	3.66	4.4	5.58
90th	4.82	5.21	5.26	6.13	7.46	9.98
January 2010 equities (n= 492)						
10th	0.36	0.4	0.44	0.55	0.71	1.13
20th	0.63	0.73	0.82	1.09	1.57	3.63
30th	1.27	1.52	1.67	2.48	4.2	8.21
40th	2.01	2.31	2.69	4.46	7.75	12.9
50th	3.09	3.9	4.62	6.98	11.08	17.75
60th	4.04	5.48	6.66	10.19	14.79	25.39
70th	5.29	7.57	10.01	15.33	24.24	38.22
80th	6.3	10.2	15.58	25.28	37.54	54.93
90th	8.49	15.82	24.66	42.41	63.39	102.16

Note: Percentiles by security of the mean liquidity measure for each security of the sample period.

Figure 21. Median effective spread by trade size (.01 = 1 basis point)



Note: Ranges in thousands NIS. Median effective spread within each trade size range. All transactions within a trade size range are aggregated together. An order submission that "walks down the book" is considered as a single transaction.

Table 10. Effective spread percentiles on the TASE by trade size

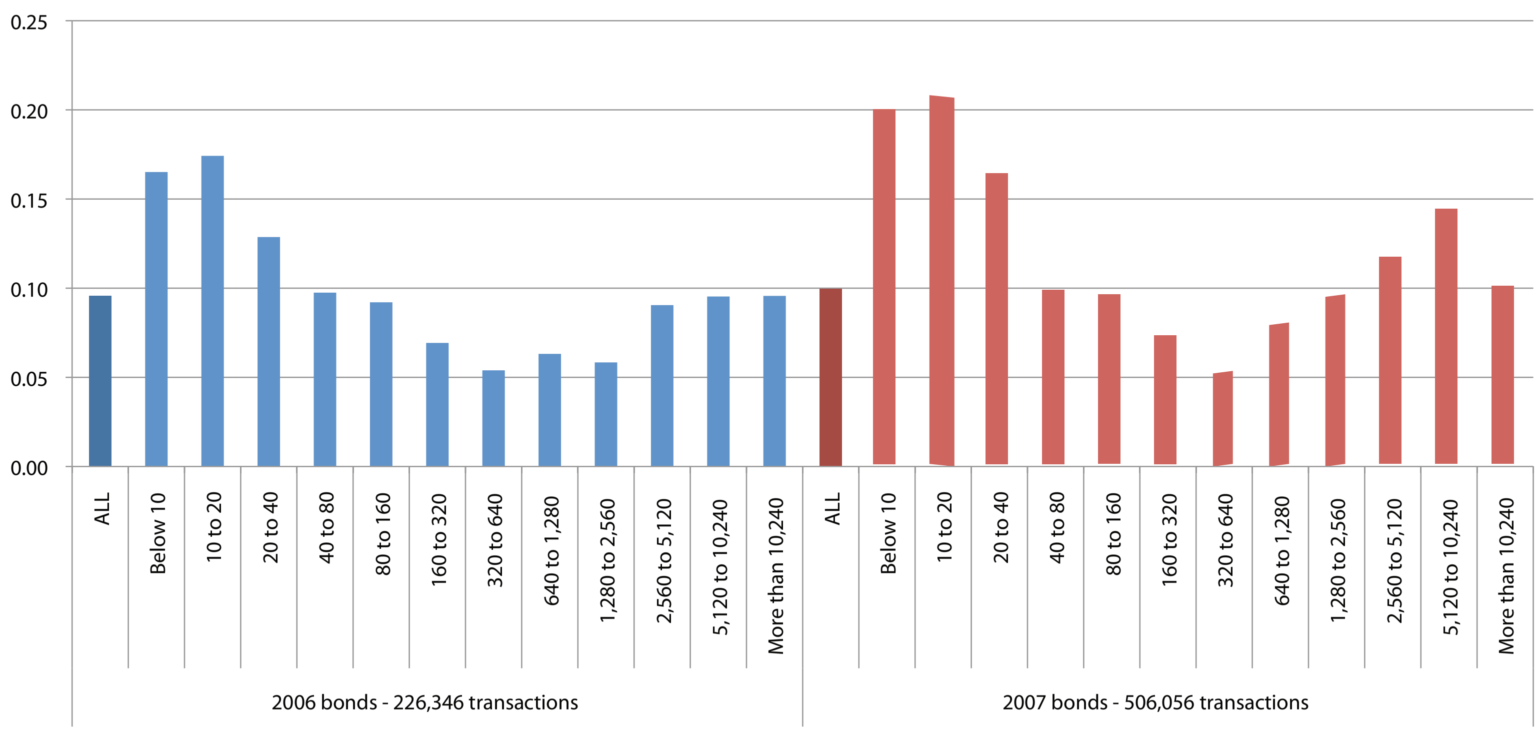
	ALL	Below 10	10 to 20	20 to 40	40 to 80	80 to 160	160 to 320	320 to 640	640 to 1,280	1,280 to 2,560	2,560 to 5,120	5,120 to 10,240	Above 10,240
Bonds Mar 2009													
10th	0.0169	0.0110	0.0179	0.0165	0.0161	0.0177	0.0211	0.0196	0.0089	0.0002	0.0002	0.0002	0.0002
20th	0.0367	0.0358	0.0432	0.0361	0.0350	0.0361	0.0380	0.0368	0.0291	0.0214	0.0115	0.0002	0.0002
30th	0.0612	0.0765	0.0742	0.0593	0.0524	0.0552	0.0568	0.0544	0.0451	0.0439	0.0569	0.0002	0.0091
40th	0.0908	0.1349	0.1110	0.0889	0.0799	0.0806	0.0802	0.0765	0.0686	0.0730	0.0898	0.0002	0.0439
50th	0.1350	0.2442	0.1810	0.1305	0.1102	0.1103	0.0974	0.0966	0.0936	0.1252	0.1561	0.0089	0.0455
60th	0.2086	0.4156	0.2899	0.1977	0.1679	0.1676	0.1271	0.1121	0.1336	0.2080	0.2186	0.0357	0.0455
70th	0.3417	0.6800	0.4796	0.3141	0.2585	0.2474	0.1887	0.1633	0.2037	0.3455	0.3856	0.0530	0.1747
80th	0.5931	1.1236	0.8195	0.5378	0.4355	0.4037	0.3140	0.2557	0.3871	0.5714	0.5926	0.1104	0.4137
90th	1.2055	2.2727	1.5385	1.0662	0.8936	0.8050	0.6328	0.5615	0.8409	1.7042	1.9791	0.4317	0.6666
N	*160,452*	*17,473*	*39,249*	*42,551*	*31,349*	*16,876*	*8,461*	*3,126*	*787*	*286*	*180*	*104*	*10*
Bonds Jan 2010													
10th	0.0170	0.0091	0.0173	0.0182	0.0200	0.0221	0.0255	0.0241	0.0168	0.0100	0.0002	0.0002	0.0084
20th	0.0399	0.0169	0.0430	0.0411	0.0430	0.0427	0.0452	0.0426	0.0346	0.0342	0.0162	0.0338	0.0251
30th	0.0633	0.0363	0.0699	0.0643	0.0648	0.0650	0.0661	0.0609	0.0552	0.0561	0.0410	0.0508	0.0443
40th	0.0860	0.0599	0.0954	0.0856	0.0853	0.0850	0.0837	0.0792	0.0822	0.0847	0.0590	0.0713	0.0461
50th	0.1145	0.0921	0.1325	0.1124	0.1107	0.1102	0.1014	0.0975	0.1061	0.1107	0.0852	0.1102	0.0506
60th	0.1582	0.1388	0.1845	0.1535	0.1493	0.1484	0.1383	0.1293	0.1382	0.1477	0.1309	0.1685	0.0703
70th	0.2222	0.2099	0.2621	0.2114	0.2048	0.1998	0.1926	0.1792	0.1854	0.1999	0.1709	0.2477	0.1018
80th	0.3309	0.3386	0.3884	0.3142	0.2965	0.2918	0.2816	0.2669	0.2688	0.3176	0.3423	0.4253	0.1686
90th	0.5710	0.6454	0.6832	0.5377	0.4944	0.4875	0.4837	0.4563	0.4684	0.5023	0.5972	0.7483	0.5657
N	*201,213*	*19,804*	*58,884*	*56,246*	*36,845*	*17,680*	*7,515*	*2,699*	*811*	*367*	*261*	*84*	*17*
Equity Jan 2010													
10th	0.0381	0.0375	0.0364	0.0384	0.0382	0.0408	0.0457	0.0458	0.0452	0.0377	0.0260	0.0198	
20th	0.0561	0.0591	0.0535	0.0535	0.0520	0.0545	0.0567	0.0563	0.0582	0.0536	0.0400	0.0279	
30th	0.0693	0.0847	0.0641	0.0633	0.0613	0.0604	0.0612	0.0633	0.0786	0.0673	0.0595	0.0586	
40th	0.0947	0.1177	0.0911	0.0866	0.0776	0.0687	0.0775	0.0882	0.0978	0.0868	0.0922	0.0788	
50th	0.1265	0.1685	0.1222	0.1150	0.0976	0.0923	0.0975	0.1101	0.1220	0.1122	0.1276	0.0837	0.5391
60th	0.1767	0.2404	0.1691	0.1532	0.1245	0.1176	0.1203	0.1333	0.1580	0.1560	0.1797	0.1392	
70th	0.2536	0.3535	0.2384	0.2061	0.1684	0.1463	0.1562	0.1682	0.1929	0.2102	0.2445	0.1929	
80th	0.3983	0.5705	0.3618	0.3077	0.2432	0.2058	0.2080	0.2189	0.2883	0.3332	0.3433	0.3599	
90th	0.7692	1.1195	0.6655	0.5433	0.4247	0.3618	0.3390	0.3670	0.5406	0.5424	0.7839	0.4697	
N	*803,398*	*345,218*	*175,323*	*132,206*	*90,277*	*41,765*	*13,355*	*3,818*	*958*	*312*	*132*	*33*	*1*

Table 10. Effective spread percentiles on the TASE by trade size (continued)

	ALL	Below 10	10 to 20	20 to 40	40 to 80	80 to 160	160 to 320	320 to 640	640 to 1,280	1,280 to 2,560	2,560 to 5,120	5,120 to 10,240	Above 10,240
All corporate bonds 2006 (whole year – all transactions)													
10th	0.0160	0.0117	0.0158	0.0211	0.0191	0.0175	0.0114	0.0044	0.0115	0.0115	0.0166	0.0169	0.0113
20th	0.0316	0.0367	0.0388	0.0401	0.0352	0.0321	0.0244	0.0151	0.0231	0.0238	0.0297	0.0317	0.0290
30th	0.0473	0.0619	0.0680	0.0573	0.0496	0.0471	0.0389	0.0277	0.0375	0.0380	0.0422	0.0473	0.0460
40th	0.0657	0.0982	0.1035	0.0884	0.0683	0.0621	0.0506	0.0413	0.0485	0.0477	0.0615	0.0741	0.0731
50th	0.0956	0.1651	0.1742	0.1287	0.0975	0.0921	0.0693	0.0539	0.0632	0.0584	0.0905	0.0953	0.0957
60th	0.1452	0.2508	0.2634	0.2000	0.1489	0.1355	0.0982	0.0796	0.0864	0.0868	0.1406	0.1453	0.2170
70th	0.2327	0.4130	0.4040	0.3192	0.2374	0.2123	0.1638	0.1128	0.1214	0.1187	0.2024	0.2383	0.3246
80th	0.4009	0.6818	0.6514	0.5166	0.4012	0.3716	0.2757	0.1929	0.2005	0.1983	0.3290	0.3880	0.5477
90th	0.8001	1.3086	1.2344	0.9747	0.7793	0.7229	0.5574	0.4020	0.4075	0.4583	0.6623	0.6667	0.8331
N	226,346	12,086	9,290	50,640	56,493	40,227	27,344	17,502	7,076	3,248	1,643	642	155
All corporate bonds 2007 (whole year – all transactions)													
10th	0.0156	0.0125	0.0129	0.0199	0.0153	0.0133	0.0100	0.0150	0.0168	0.0179	0.0186	0.0184	0.0119
20th	0.0287	0.0399	0.0414	0.0390	0.0270	0.0275	0.0218	0.0247	0.0287	0.0305	0.0364	0.0374	0.0274
30th	0.0461	0.0790	0.0825	0.0606	0.0450	0.0431	0.0342	0.0354	0.0439	0.0469	0.0498	0.0569	0.0464
40th	0.0680	0.1184	0.1265	0.0965	0.0664	0.0601	0.0474	0.0432	0.0515	0.0669	0.0845	0.0917	0.0722
50th	0.0998	0.1990	0.2068	0.1631	0.0977	0.0950	0.0722	0.0522	0.0793	0.0951	0.1161	0.1431	0.0999
60th	0.1748	0.3207	0.3278	0.2616	0.1657	0.1520	0.1058	0.0840	0.1054	0.1452	0.1813	0.2232	0.1615
70th	0.2844	0.5109	0.5047	0.4211	0.2681	0.2521	0.1889	0.1253	0.1836	0.2206	0.2809	0.3512	0.2479
80th	0.4928	0.8724	0.8447	0.6931	0.4607	0.4394	0.3390	0.2344	0.2988	0.3846	0.4585	0.5535	0.3820
90th	0.9853	1.6262	1.5625	1.2658	0.9048	0.8728	0.7345	0.5021	0.6182	0.7614	0.8807	0.9429	0.9053
N	506,056	23,857	17,588	118,894	126,016	87,738	59,143	44,393	15,985	6,468	3,832	1,595	547

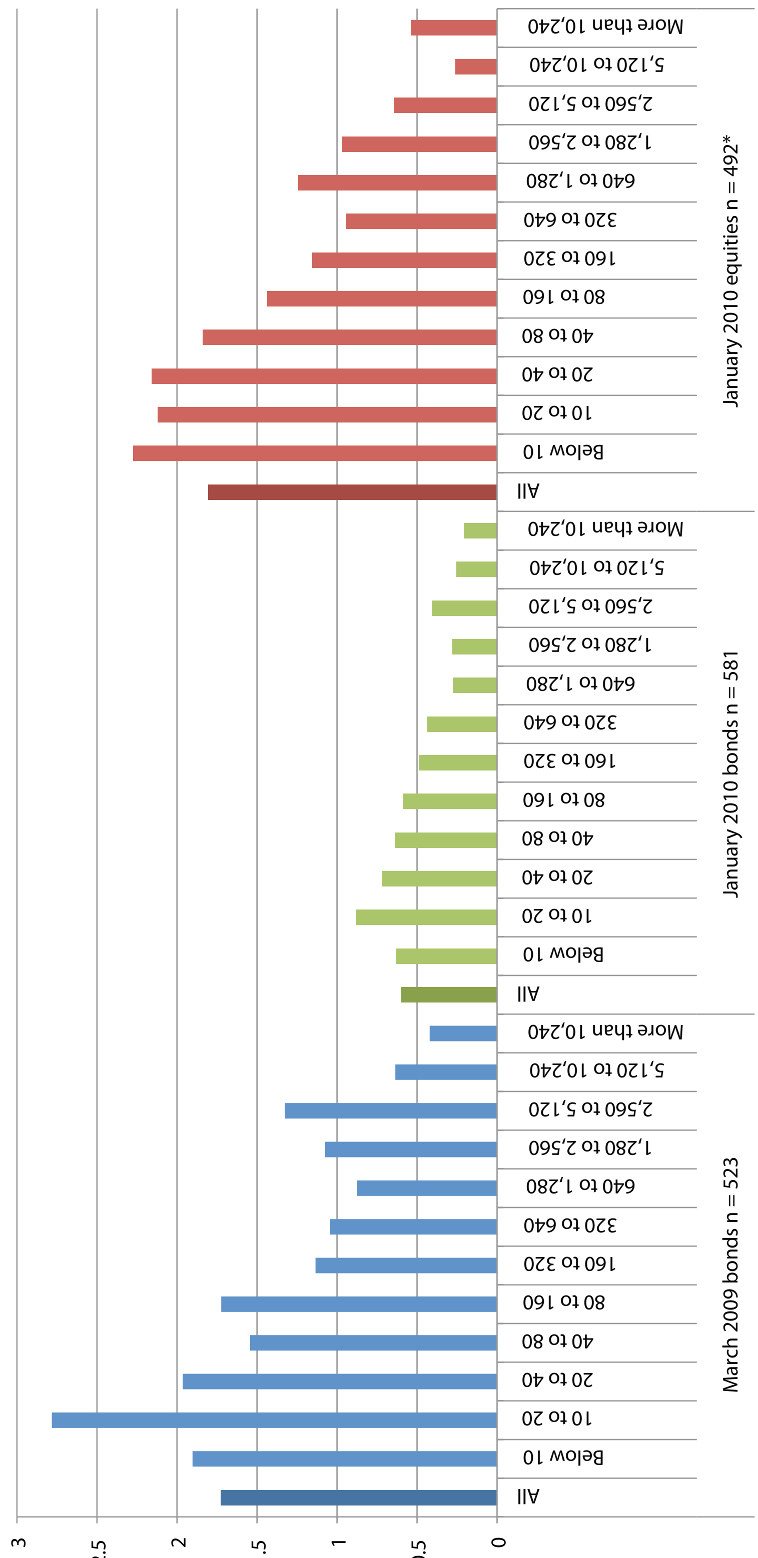
Note: Percentile schedules of effective spread within each trade size range. All transactions within a trade size range are aggregated together. An order submission that "walks down the book" is considered as a single transaction. .01 = 1 bp; ranges in NIS thousands.

Figure 21. Median effective spread by trade size 2006 - 2007 (.01 = 1 basis point)



Note: Ranges in thousands NIS. Median effective spread within each trade size range. All transactions within a trade size range are aggregated together. An order submission that "walks down the book" is considered as a single transaction.

Figure 22. Mean Security effective spread by trade size (.01 = 1 basis point)



Notes: Mean of each security's median effective spread by transaction by trade size.
*580 equity securities had TASE transactions in January 2010; however, only 492 of these securities had transactions during continuous trading.

Appendix 6: Poisson Regression Results

TABLE 11. EX-ANTE LIQUIDITY MEASURES ON TRANSACTION FREQUENCY BY TRANSACTION SIZE INTERVAL

Panel 1: Bonds

Five-minute average ex-ante liquidity measures to the following 60 minutes transaction frequency (6 periods each day; final period is truncated from 3:30 – 4:15)

		All bonds			*All bonds except Tel Bond 60*			*Tel Bond 60 bonds with tradable equity*		
		Obs = 68981			*Obs = 64709*			*Obs = 4914*		
NIS range		Parameter	SE	*R squared*	Parameter	SE	*R squared*	Parameter	SE	*R squared*
₪ 0 to ₪ 7,500	CRT(₪ 5,000)	-0.4853	0.0116	*5.59%*	-0.2966	0.0098	*3.48%*	-1.012	0.1163	*0.86%*
	QIS	-0.7611	0.0165	*8.17%*	-0.4849	0.014	*5.60%*	-1.3826	0.1279	*1.43%*
₪ 7,500 to ₪ 15,000	CRT(₪ 10,000)	-0.7194	0.0087	*11.10%*	-0.4638	0.0075	*7.51%*	-0.6995	0.0589	*0.82%*
	QIS	-0.8063	0.0097	*11.34%*	-0.5209	0.0084	*7.69%*	-0.7625	0.0635	*0.82%*
₪ 15,000 to ₪ 37,500	CRT(₪ 25,000)	-0.9345	0.0078	*17.47%*	-0.6219	0.0067	*12.57%*	-1.4753	0.0514	*4.19%*
	QIS	-1.2296	0.0103	*17.50%*	-0.8229	0.009	*12.72%*	-1.6528	0.0593	*3.84%*
₪ 37,500 to ₪ 75,000	CRT(₪ 50,000)	-1.0612	0.0108	*18.40%*	-0.7329	0.0095	*13.99%*	-1.8721	0.0697	*5.27%*
	QIS	-1.6173	0.0169	*17.40%*	-1.1105	0.015	*13.29%*	-2.2092	0.088	*4.56%*
₪ 75,000 and up	CRT(₪ 100,000)	-0.9678	0.01	*19.06%*	-0.716	0.0091	*15.32%*	-1.3298	0.0584	*4.84%*
	QIS	-1.6814	0.0191	*16.53%*	-1.1757	0.0169	*13.22%*	-2.7396	0.1088	*5.60%*

Panel 2: Matched Tel Bond 60 bonds and equity

15-minute average ex-ante liquidity measures to the following 15 minutes transaction frequency (26 periods each day for bonds; 24 for equities)

		Equities matching Tel Bond 60				*Tel Bond 60 bonds with tradable equity*			
		Obs = 12920		*Securities = 27*		*Obs = 21294*		*Securities = 39*	
NIS range		Parameter	SE	*R squared*	Trans count	Parameter	SE	*R squared*	Trans count
₪ 0 to ₪ 7,500	CRT(₪ 5,000)	-0.8961	0.0908	*4.63%*	59720	-0.8605	0.0953	*0.51%*	3339
	QIS	-1.2395	0.1038	*4.86%*		-1.6611	0.1182	*1.49%*	
₪ 7,500 to ₪ 15,000	CRT(₪ 10,000)	-0.7433	0.0473	*15.89%*	52196	-0.9306	0.0534	*0.89%*	10706
	QIS	-0.8558	0.0535	*13.31%*		-0.9556	0.0583	*0.76%*	
₪ 15,000 to ₪ 37,500	CRT(₪ 25,000)	-1.4818	0.0401	*21.80%*	54894	-1.6911	0.0473	*3.21%*	16464
	QIS	-1.791	0.0491	*15.85%*		-1.9343	0.0561	*2.92%*	
₪ 37,500 to ₪ 75,000	CRT(₪ 50,000)	-1.7469	0.0507	*25.39%*	26652	-1.98	0.0635	*3.89%*	8633
	QIS	-2.5035	0.0723	*16.79%*		-2.6511	0.0858	*3.66%*	
₪ 75,000 and up	CRT(₪ 100,000)	-1.1556	0.0384	*27.41%*	17132	-1.5984	0.0562	*4.49%*	6224
	QIS	-2.8312	0.087	*17.17%*		-3.216	0.109	*5.29%*	

All QIS measures include QID as an additional regressor. QID parameter estimates are not statistically significant.

Appendix 7: List of Firms in Sample

Tel-Bond 60 Firms with TASE-Listed Equity
These 27 firms account for 39 Tel-Bond 60 bonds listed on the TASE in January 2010.

סלקום ישראל בע״מ Cellcom Israel Ltd.	בזק החברה הישראלית לתקשורת בע״מ Bezeq, The Israel Telecommunication Corp., Ltd.
אמות השקעות בע״מ Amot Investments Ltd.	בתי זיקוק לנפט בע״מ Oil Refineries Ltd. (Bazan)
רבוע כחול נדל״ן בע״מ Blue Square Real Estate Ltd.	אלוני-חץ נכסים והשקעות בע״מ Alony-Hetz Properties & Investments Ltd.
פז חברת נפט בע״מ Paz Oil Company Ltd.	החברה לישראל בע״מ Israel Corporation Ltd.
בריטיש - ישראל השקעות בע״מ British Israel Investments Ltd.	כלל תעשיות והשקעות בע״מ Clal Industries and Investments Ltd.
קרדן אן.וי. Kardan N.V.	חברת השקעות דיסקונט בע״מ Discount Investment Corporation Ltd.
קבוצת דלק בע״מ Delek Group Ltd.	כור תעשיות בע״מ Koor Industries Ltd.
אלביט הדמיה בע״מ Elbit Imaging Ltd.	חברה לנכסים ובנין בע״מ Property and Building Corp. (IDB)
דלק נדל״ן בע״מ Delek Real Estate Ltd.	גזית אינק. Gazit-Globe Ltd.
שיכון ובינוי בע״מ Shikun & Binui Ltd. – Arison Group	אי די בי חברה לאחזקות בע״מ I.D.B Holdings Limited.
מכתשים - אגן תעשיות בע״מ Makteshim Agan Group Ltd.	שטראוס גרופ בע״מ The Strauss Group Ltd.
גזית-גלוב בע״מ Gazit Globe Israel Ltd.	חברת גב-ים לקרקעות בע״מ Gav-Yam Group
כלכלית ירושלים בע״מ Jerusalem Economy Ltd.	שופרסל בע״מ Shufersal Ltd.
חברת מבני תעשיה בע״מ Industrial Buildings Corporation Ltd.	

Endnotes

1. We call these "tradable" bonds or "exchange-listed" bonds. The remaining third, called non-tradable bonds, are not open to public trading. Non-tradable bonds are privately placed without prospectus delivery requirements; the general public is not permitted to invest in them. We analyze liquidity of the tradable bonds, as these are the bonds available to the public. Except when otherwise specified, we refer exclusively to tradable bonds.

2. The recently passed Dodd-Frank Wall Street Reform Act in the U.S. is a good example. See this *New York Times* analysis: http://dealbook.blogs.nytimes.com/2010/07/19/a-new-world-begins-for-wall-street-oversight/?ref=business.

3. Eddy Wymeersch, chairman of the Committee of the European Securities Regulators, recently identified the corporate bond market as a possible target for regulator enforced market structure change in a speech before the ISA staff (May 2010). In 2006, Chester Spatt, then chief economist of the SEC, made a speech in which he brought up the possibility of imposing *pre-trade* transparency on the corporate bond market–a move that would effectively change the underlying market structure (Spatt 2006).

4. As of the IOSCO report, the Standing Committee on Secondary Markets (SC2) countries were Australia, Brazil, Canada, France, Germany, Hong Kong, Italy, Japan, Malaysia, Mexico, Singapore, Spain, Switzerland, United Kingdom, and the United States. (IOSCO)

5. Trader identity may convey significant information to market participants, especially if market participants can infer the current position or the possible information a given trader may hold.

6. Hidden orders are not displayed, but will be transacted against if the rules of the exchange are satisfied. "Iceberg" orders appear on the book, but the full size of the quote is not displayed.

7. For a detailed description, see FINRA's website: http://www.finra.org/Industry/Compliance/MarketTransparency/TRACE/

8. See also Biais et al. (2005), who make a general survey of liquidity phenomenon and describe this issue in particular detail, and Madhavan et al. (1999), who provide an exposition and empirical results consistent with the existence of this phenomenon.

9. These figures include issues made internationally by the firms in the specified country. If outstanding corporate bond debt is limited to only domestic issuances, then Israel, with 24 percent of GDP, is roughly on par with Italy and Iceland, but ahead of the United States (19 percent of GDP) and France (10 percent of GDP).

10. As measured in real (April 2010) dollars.

11. Securitizations may have substituted for corporate bonds in some jurisdictions in 2009, but they were developed in Israel. This may explain part of the relative popularity of corporate bonds in Israel.

12. The CEPR study does not include retail-size trades, making their results particularly high compared to the American results.

13. For these results, and all following results unless otherwise specified, we consider a single "trade" as all transactions that occur when a given order is submitted, transacts immediately, and walks down the book. We believe this more accurately represents the desired trade size of the order-submitting participant, and that this method of counting is more directly comparable to the sort of bilateral transaction exhibited on a dealer market.

14. Bank of Israel notes, however, that this is an overestimation since some corporate bonds are held by the subsidiaries of the bond issuers.
15. Gomber et al. (2004) examine ex-ante liquidity around large transactions directly. They measure liquidity leading up to and following large transactions and find that large transactions occur during periods of high liquidity, and that liquidity reverts to "normal" levels following the transaction.
16. See also Tenikue (2004), which employs the same measure.
17. Benston et al. use 10 ticks above (below) the *best* ask (bid) quotes. Because of the prevalence of quotes that are far worse than the best quote in our sample, this leads to higher trading sizes exhibiting lower CRT then lower trading size. This is a nonsensical result. By increasing the tick penalty, we eliminate this problem.
18. The relatively strong performance of bonds may be because of the time our sample was taken. January 2010 represented a rebound in the bond and equity markets following the crisis. The rebound may have been stronger in the bond market and therefore coincided with better liquidity.
19. The Poisson regression is a common method for analyzing count data. The basic relationship in the univariate is expressed as: $\log\left(E\,(y_i|x_i)\right) = a + bx_i$
20. We present McFadden's pseudo r-squared: $1 - \dfrac{Log\ Likelihood_{Model}}{Log\ Likelihood_{Null}}$
21. Tel Bond 60 is an index of large corporate bonds traded on the TASE.
22. Many exchanges already disclose the entire limit order book, including the NYSE (through the Open Book service), the SWXess platform of SIX (Switzerland), the London Stock Exchange (through Infolect), and Chi-X (Europe) (through various data-vendors, including the Bloomberg Terminal) (visible orders only). The Deutsche-Boerse Group discloses discloses the top ten and twenty quotes on each side of the book for Xetra (equities) and Eurex (derivatives) platforms respectively.
23. NASD was the self-regulatory organization (SRO) responsible for the licensure of securities dealers in the U.S. In July 2007, it was replaced by the Financial Industry Regulatory Authority (FINRA), which is also an SRO.
24. CESR has released four reports in this regard: CESR/07-284b (2007), CESR/08-1014 (2008), CESR/09-348 (2009), and CESR/10-510 (2010).
25. Dr. Wymeersch spoke before the Israel Securities Authority staff in May 2010.
26. In 1997, the SEC implemented rules requiring NASDAQ to display some limit orders quotations of non-dealer investors.
27. "Indicative quotes" are not a guarantee to trade.
28. Ronaldo (2004) provides an interesting analysis of order submission on a pure limit order book.

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