

Deep-Market by IAS-19: A Unified Cross-Country Approach for Discount Rate Selection*

Haim Kedar-Levy

Ben Gurion University of the Negev, Israel

Elroi Hadad

Shamoon Collage of Engineering (SCE), Israel

Gitit Gur-Gershgoren

Ono Academic College, Israel

The discount rate reporting entities apply for future employee benefits obligations has a profound impact on their present value, both at the firm and at the country level. The IAS-19 accounting standard requires the existence of a ‘deep market’ in high-quality corporate bonds in order to use their yields as the discount rate, and in its absence, the often-lower government bond yields should be used. From a financial economics perspective, the term ‘deep market’ is vaguely defined in IAS-19, therefore we propose a dual approach. First, from the macro-economic perspective, we explore funding liquidity, and second, from the micro-economic perspective, we measure the illiquidity premium in high-quality corporate bonds. We argue that both aspects are essential because they are inter-connected. Our approach is tested empirically on a sample of 32 countries, with detailed analysis of the Israeli market as a case in point. (JEL: G12, G18, M40, M41, M48)

Keywords: IAS-19; deep market; employee benefits; market liquidity; funding liquidity

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I. Introduction

IAS-19 Employee Benefits (2011), of the International Financial Reporting Standards (IFRS) ('the standard'), prescribes the accounting treatment and disclosure that entities are required to implement when estimating obligations for employee benefits, funded and unfunded. One of the important actuarial assumptions in IAS-19 concerns the interest rate by which post-employment benefits should be discounted. Given the long durations of expected cash flows, small changes in the discount rate have profound effects on entities' liabilities in the jurisdiction, and thus on their financial stability. Due to that this sensitivity, cross-country uniformity in the classification of jurisdictions into the deep or not deep categories is important for a uniform implementation of accounting standards. To date, no uniform methodology has been proposed on this matter.

Paragraphs 83-86 of the standard prescribe that post-employment benefit obligations shall be discounted by the average yield to maturity of high-quality corporate bonds (HQCB). Yet, in the absence of a 'deep market', these obligations should be discounted by government bond yields. Many questions were addressed to an IFRS Interpretations Committee (IFRIC), primarily regarding the meaning of the term 'deep market', which was associated with the term "tradability". In its November 2013 release the committee deferred the discussion to an IASB's research project on discount rates.¹ In that release the committee highlighted that the concept of 'high quality' should be absolute, and not relative, indicating that HQCBs within a jurisdiction should not be measured vis-à-vis local assets (a relative definition would say 'highest quality') but vis-à-vis an absolute measure of quality. This is essential to secure a uniform implementation of the standard across jurisdictions, and hence, our paper contributes by offering uniform and objective measures of "deepness". However, the committee did not provide a formal definition to the term 'deep market' and guidance on how should

1. IFIRC update, November 2013:
(<http://media.ifrs.org/2013/IFRIC/November/IFRIC-Update-November-2013.html#2>)

it be assessed, given the need for global uniformity.² Our paper is the first to propose a robust methodology to implement a globally consistent classification of jurisdictions into the ‘deep’ or ‘not deep’ categories. This means that “deepness” is measured in each jurisdiction, partly to restrict opportunistic assumptions by individual firms. We use the Israeli market as a case in point, while showing results for all countries in the sample.

We start from the observation that the terms ‘deep market’ and ‘liquidity’ have both macro- and micro-economic interpretations. According to the macro-economic interpretation, liquidity and market depth concern the ability of the financial system to provide lines of credit to borrowers, particularly in stressful times (‘funding liquidity’). However, liquidity and depth by the micro-economic interpretation are asset-specific attributes, and when aggregated, market-specific attributes (‘market liquidity’). Yet, these two notions of liquidity are inter-connected because financial markets cannot be liquid and deep without a well-developed financial sector that provides funding for trade (Brunnermeier and Pedersen, 2009).

We argue that a comprehensive examination is required prior to determining whether a corporate bond market in a jurisdiction indeed qualifies as ‘deep market’ by IAS-19. Assume, for example, that a financial panic hits the jurisdiction, and debt markets become illiquid by the micro-economic sense. A typical outcome is that spreads widen thus rolling-over debt becomes prohibitively expensive. If funding liquidity is available, a supply of credit by financial institutions can ameliorate market illiquidity by narrowing spreads. In fact, the U.S. Fed’s expansionary policy following the stock market crash of October 1987 and after the Lehman Brothers’ collapse in September 2008 attest to the interconnectedness between these two aspects of liquidity. Additional evidence for this linkage is given in the literature review section below.

Our fundamental claim is as follows: The depth of the corporate bond market depends on both, the funding and market liquidity aspects, and these two are interconnected in a reinforcing way, i.e., if one

2. Global uniformity refers to jurisdictions that adopt International Accounting Standards, otherwise the linkage between market depth and discount rates is arbitrary. Some countries in our sample do not require IFRS adoption as a mandatory policy (Japan, Switzerland and US), yet our test classifies them as “deep”, irrespective of their stated policy. In some cases, interested parties deployed lobbyists to tilt the classification of jurisdiction as having or not a ‘deep market’ according to their position.

deteriorates it will cause the other to deteriorate as well (Brunnermeier and Pedersen, 2009). Because IAS-19 requires that the HQCB market as a whole be ‘deep’, both aspects must be met. If a jurisdiction meets only one of the requirements, it cannot meet the IAS-19 requirement because of the interconnectedness.

We conduct two independent studies: First, we examine macro-economic liquidity by comparing macro ratios as published by the World Bank (see section III) of two groups of jurisdictions: those having and those not having a deep market. Using a linear discriminant analysis (LDA), we measure the probability of an out-of-sample jurisdiction, Israel as an example, to be classified to one of the two groups, thus assuring cross-country consistency. Second, we use more than 220,000 daily trading records of about 245 corporate bonds to measure the average liquidity premium and compare it to the average liquidity premium in the U.S. To assure comparability across jurisdictions, a local premium should not differ statistically from a reference premia as measured in deep-market jurisdictions. This satisfies IFRIC’s interpretation of an ‘absolute’ scale for ‘high quality’, since premia on low quality bonds must be higher than high quality bonds. We report classification results for all countries and show that while Israel, Brazil and China did not classify themselves as having a deep market, they do belong to this group starting 2009. By the microeconomic aspect, we find that the Israeli HQCBs that are indexed to the CPI qualify as being ‘deep’. Because we require the market to be ‘deep’ by both aspects, only the segment of indexed bonds meets the IAS-19 requirement. Based on these findings, the Israel Securities Authority determined that a deep market exists in indexed corporate bonds.

The remainder of this paper presents a brief review of the literature in the next section, followed by presentation of the first requirement, the macroeconomic aspect, with its methodology, data, and the results. This section is followed by the second, microeconomic requirement, featuring the methodology, data, and a comparative analysis vs. the U.S. market. The final section summarizes the results and concludes the paper.

II. A Brief Literature Review

From the macroeconomic perspective of market depth, Brunnermeier

and Pedersen (2009) suggest a theoretical model to link between assets' market liquidity and traders' funding liquidity, defined as the ease with which they can obtain funding from financial institutions. In this model, traders provide market liquidity but their ability to do so depends on the supply of liquid sources by the financial system. The authors show that the financial system will supply more liquid sources as the market liquidity increases, and vice versa. Consequently, a mutually reinforcing interaction between the two types of liquidity exists: when one increases (declines), the other increases (declines) as well. The model explains several empirical regularities documented in the market liquidity literature, including: (a) market liquidity can rapidly and suddenly 'dry-up'; (b) it is correlated across a large number of financial assets; (c) it is related to market volatility; (d) it is subject to 'flight to quality'; and (e) its movements are correlated with the markets.³ Some of those predictions were tested in several empirical studies including Hameed, Kang, and Viswanathan (2010) and Karolyi, Lee, and Van Dijk (2012), showing, among other things, that negative market returns contribute to a decline in stock liquidity and an increase in commonality-in-liquidity. Several papers, including Longstaff (2004) and Næs, Skjeltorp and Ødegaard (2011), highlight the severity of the flight-to-quality phenomenon. This finding is highly relevant to our study since flight-to-quality generally reduces government bonds yields, therefore, by IAS-19 the present value of obligations increases when firms are in financial stress, possibly leading to bankruptcies. From a global macroeconomic perspective, Mendoza, Quadrini, and Rios-Rull (2009) show that differences in financial markets' development, market depth in our context, contribute to financial imbalances across countries. Their results stem from the observation that the process of financial markets' globalization was not aligned with local financial development.

A relevant case in point is the pattern of IAS-19 adoption in Sweden between 2010 and 2011. While some firms adopted the standard in 2010, other firms adopted it later, in 2011 (Martinsson and Edqvist, 2013). As figure 1 shows, between 2007 and 2012 the financial crisis triggered flight-to-quality, thus government bond yields fell from about 4.40% in the second half of 2007, to about 2.38% in December 2008 and to about 1% in late 2011 and 2012. At the same time yields on "deep" long-term mortgages, which until the beginning of 2007 were

3. Flight to quality is expressed in turbulent periods, as investors reduce their exposure to risky assets and purchase less risky assets, predominantly government bonds.

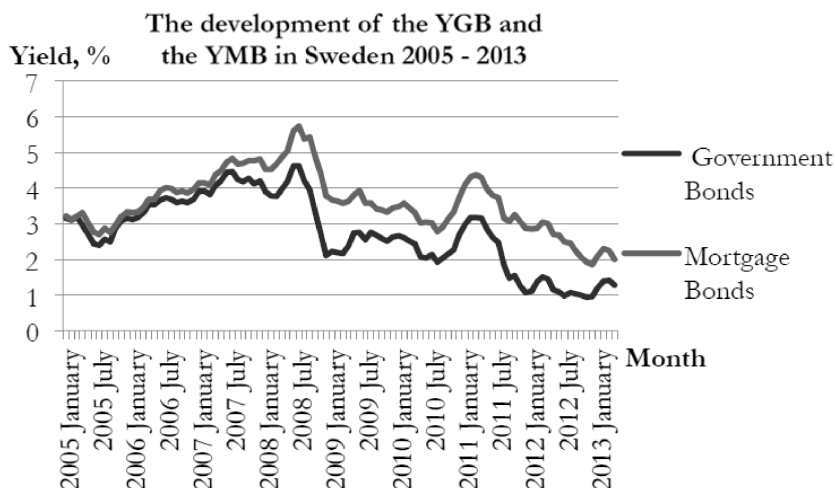


FIGURE 1.

Note: Source: Martinsson, F. and K. Edqvist, 2013. YGB - Yield on Government Bonds; YMB - Yield on Mortgage Bonds.

slightly higher than government bonds, started increasing. In mid-2008 and then again in 2011 this spread peaked, reaching about 1.5%-2% during the second half of 2011. This opening of the spread resulted in large differences in the present value of corporate liabilities across adopting vs. not-adopting firms of IAS-19.

The implications of different discount rate assumptions by different entities in each jurisdiction distort important financial ratios, primarily those related to leverage and profitability (Glaum, 2009). Glaum (2009) also estimates that a one percentage point increase in IAS-19 discount rate may result in a decline of about 15% of pension liabilities. Given the 2% spread as measured in 2011 in Sweden the estimates of corporate liabilities might differ by about 30%, as shown in figure 2. For example, the present value of 100 discounted by 2.5% over 20 years is about 60, and it declines to about 40 if the discount rate is 2% higher, a 30% decline. These examples testify on the importance of uniformity of IAS-19 implementation across jurisdiction, let alone within a given jurisdiction.

Bernanke (2013) is an additional contribution highlighting the importance of trading liquidity and its association with financial institutions' stability. Bernanke points out that as the 2008 crisis unfolded, liquidity turned out to be an issue more severe than the mere

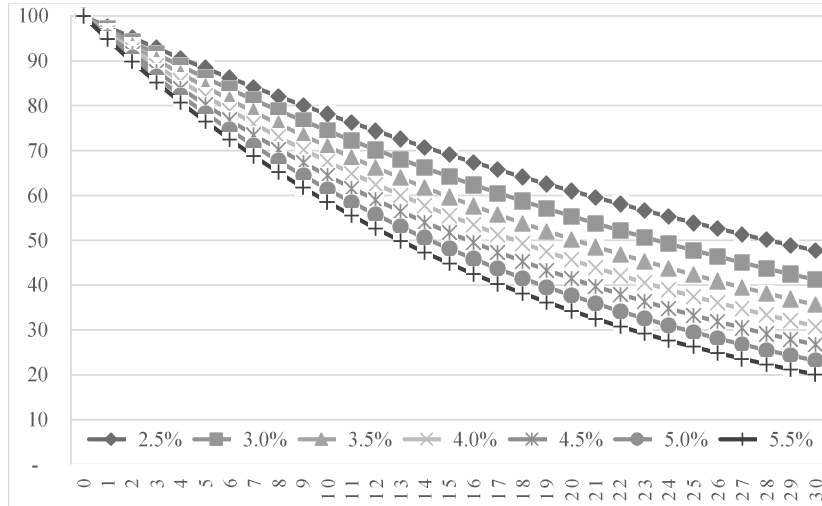


FIGURE 2.

Note: The present value of 100 for varying durations and discount rates. Authors' compilation.

fact that markets showed low turnovers. Many financial institutions were unable to obtain funding to support their positions in financial assets (primarily short-term ones, such as the Repo market), therefore faced two alternatives: to enter a state of insolvency or sell assets in the distressed market at considerable losses. When such distressed conditions undermine the stability of a certain institution, concerns of its collapse spread, and trickle down in a contagion process to trigger concerns regarding the stability of other, possibly related institutions. Funding liquidity and market liquidity feed each other through this additional channel.

From the micro-economic perspective of market depth and liquidity, the literature on credit risk modelling provides evidence that an illiquidity premium is incorporated in corporate bond spreads. Duffie and Singleton (1999), Longstaff, Mithal and Neis (2005), Liu, Longstaff and Mandell (2006) and Acharya, Amihud and Bharath (2013) find an economically meaningful liquidity premium in corporate bond yields, which is negatively correlated with bond quality. Amihud's (2002) *ILLIQ* measure, that relates the price impact of trades to trading volume, is considered by many the most widespread and accepted measure for

estimating illiquidity and the illiquidity premium (Friewald, Jankowitsch and Subrahmanyam, 2012). Alternatively, researchers use indirect liquidity proxies, including trading volume, number of trades, and the percentage of zeros measure (days in which no change in price occurred) proposed by Chen, Lesmond and Wei (2007). We use the Amihud measure to estimate the liquidity component, yet show its consistency with other measures, like zeros.

The choice of parameters firms in a jurisdiction apply to estimate post-employment obligations draws much research attention in the recent accounting literature, partly because of their measurable impact on individual firms' liabilities, and on the aggregate. One of the key reasons for this interest is the high sensitivity of those obligations to a few parameters, such as the discount rate, the expected rate of price inflation and salary inflation. For example, Billings et al. (2017) report that firms choose key assumptions like discount rate, price inflation and salary inflation selectively, particularly by companies whose pension funding is problematic (see also Amir and Gordon, 1996). This problem was found also in the U.S., as Godwin (1999) reported that managements of companies with poor coverage of pension liabilities used less conservative discount rates, and after the Securities and Exchange Commission limited the choice of discount rates, such firms responded by lowering future salary assumptions. The implementation of IAS 19 after 2013 (though not relevant in the U.S.) did not limit this selectivity, as it still allows much leeway in management discretion, and the outcome is poor representation of reported pension liabilities.

Given the long term of expected cash flows, small variation in the assumed parameters make large changes in the present value of pension liabilities. For example, the UK Accounting Standards Board (ASB) (2007) reports that a 0.5% change in discount rate changes liabilities by 9.5%. With discount rate differential that may exceed in some cases 2%, the present value of defined benefit liabilities becomes a highly volatile element in companies' liabilities, and a target for "management".

A number of recent accounting papers address the problematic implications of discount rate selection. Naughton (2019), Fahad et al. (2019) and Pinto and Morais (2019) show substantial variation in selected discount rates, and their implications for audit fees. Naughton (2019) developed new approaches to estimate management's discretion with respect to three key assumptions of defined contribution pension plans, namely the discount rate, compensation rate, and expected return of pension assets. This is an important extension of prior research,

which predominantly focused on the expected return assumption. Naughton's findings indicate that firms reduced discretion in those cases where regulations turned more restrictive, but they compensated for the effect by increasing discretion in the remaining assumptions, where regulations did not target specifically. Firm's motivation is clear - either stabilize the valuation of pension liabilities, or even increase reported earnings.

Pinto and Morais (2019) use a sample of 72 U.K. firms to explore whether the adoption of IAS 19 improved the value relevance of pension accounting information, particularly by firms with high pension sensitivity, which were prone to manage earnings upward before the IAS 19 revision. They found that the adoption of the revised IAS 19 indeed limited the use of expected rate of return assumption and improved the value relevance of reported earnings. Fahad et al. (2019) report an annual variation in discount rate of about 4% across Australian firms, despite the AASB 119 guidance as to the choice of discount rate.

III. Requirement 1: The macroeconomic aspect

In this section, we present a framework to study market depth by the funding-liquidity aspect. By Levine (2005), a country's financial sector has several roles, among them efficient capital allocation, risk sharing, pooling of savings, and facilitating transactions. Given such a wide variety of roles, defining and measuring how well a financial system is functioning is role specific. Following the global financial crisis, the World Bank embarked on a comprehensive research project aimed at comparing financial systems across more than 200 countries. The panel database holds a wide array of annual financial and macroeconomic indicators from 1960, which is updated periodically. This 'Global Financial Development Database' (GFDD) is based on a '4x2 framework'.⁴ It includes measures of (1) depth, (2) access, (3) efficiency, and (4) stability of financial systems. Each of these characteristics captures both (1) financial institutions (banks, insurance companies, and so on), and (2) financial markets (such as stock markets and bond markets). Given our scope in this paper, we are focused on comparing depth of the corporate bond markets across countries. Surely,

4. See the World Bank website: <http://www.worldbank.org/en/publication/gfdr/data/global-financial-development-database> and Čihák, Demirgüç-Kunt, Feyen and Levine (2012).

such a comparison is ordinal: it can rank countries by their score in some depth measures, but it cannot assure that the leading ones indeed meet the IAS-19 requirement. Therefore, an exogenous benchmark is needed, and we take that to be the classification of some countries as having and others as not having a deep market by an Ernst and Young study, as detailed below.

A. Methodology

To assess the value of using macro-economic indicators as predictors of market depth, we use a version of the Discriminant Analysis (DA) model. DA is a statistical classification model used to predict the probability of correctly identifying whether an observation belongs to one of k possible groups. The most well-known application of the DA method in accounting and finance is Altman's (1968) model, where the Z-score is used to predict the likelihood of a firm's bankruptcy based on accounting ratios. Altman's model has been initially implemented on firms in the industrial sector and subsequently on firms in the financial sector.

The DA model requires pre-classification of countries to one of the groups as a benchmark. Therefore, we use a list of countries that have been defined, or defined themselves as having or not a deep market, as this was summarized in a worldwide survey by Ernst & Young.⁵ As a test case, we use the model to examine whether the Israeli market can be classified to one of the two groups at high statistical significance.

The DA method defines a binary response variable, Y , based on a matrix of explanatory variables X , and is used to determine which variables discriminate between the two (or more) categories of Y . The X variables are assumed to have a multi-variate normal distribution with common mean vector μ and a variance-covariance matrix Σ . Therefore, in the simplest case of discriminating between only two groups, the prior probability $P(X|Y)$ is

$$P(X|Y) = \begin{cases} Y = 1 & \sim N(\mu_1, \Sigma_1) \\ Y = 0 & \sim N(\mu_0, \Sigma_0) \end{cases} \quad (1)$$

Under the assumption that X is normally distributed, the DA algorithm

5. IFRS Pension Discount rate, worldwide survey of current practice, Ernst & Young, June 2013.

computes the posterior probability that observation x belongs to category k by multiplying the prior probability and the normal density function of the k th group:

$$P(x|k) = \frac{1}{\sqrt{2\pi|\Sigma_k|}} \exp\left(-\frac{1}{2}(x - \mu_k)^T \Sigma_k^{-1}(x - \mu_k)\right), \quad (2)$$

where $|\Sigma_k|$ is the determinant of Σ_k and Σ_k^{-1} is the inverse of Σ_k .

A DA analysis may use several classification methods, including linear discriminant analysis (LDA). In this case, the LDA uses a linear discriminant function (*LDF*) that passes through the centroids (geometric center) of the two groups in order to discriminate between them:

$$LDF = a + b_1X_1 + b_2X_2 + \dots + b_pX_p, \quad (3)$$

where X_j is the explanatory variable ($j = 1, \dots, p$), a is a constant, and b_1, \dots, b_p are the respective regression coefficients of p explanatory variables. For each observation i in the sample, the *LDF* calculates a score that defines observation i 's proximity to the selected baseline group.^{6, 7}

B. The dependent variable

The dependent variable is a binary variable: the country is defined as either having or not having a deep market,

$$Y_i = \begin{cases} 1 & \text{Has a deep market} \\ 0 & \text{Does not have a deep market} \end{cases} \quad (4)$$

where Y_i is the value for country I .

6. The score is calculated by the Mahalanobis distance, which is the distance between the i 's observation and the centroid of each examined group in terms of standard deviation; hence, an observation having 1.96 Mahalanobis distance or higher has less than 5% chance of belonging to that group.

7. LDA makes several statistical assumptions, including: (a) the explanatory variables are interval or ratio variables; (b) the observations in the sample are independent; (c) the explanatory variables are sampled randomly and independently from a normally distributed population; and (d) the variance-covariance matrix is homogenous across the categories. We account for these assumptions in the tests.

TABLE 1. List of countries with or without a deep market in the local corporate bonds market

Countries having a deep market	Countries not having a deep market
Japan	Australia
Norway	Brazil
Sweden	China
South Korea	Mexico
Eurozone	Poland
United States	
Canada	
UK	
Switzerland	

Note: Source: IFRS Pension Discount Rate, Worldwide Survey of Current Practice, Ernst & Young, June 2013.

The 2013 Ernst & Young report on local financial market depth by IAS-19 includes 31 countries, where having or not a ‘deep market’ is based on the self-declarations of the countries.⁸ The list appears in table 1, and it includes all 18 countries of the Eurozone.⁹

While adopting the Euro as their uniform currency, Eurozone countries are heterogeneous along different economic measures. Of particular interest is their degree of economic development as reflected in large differences in GDP per capita. Countries such as Slovakia, Latvia, and Estonia, for example, have a per capita GDP less than USD 20,000 while among western European and Scandinavian countries GDP per capita typically exceeds USD 40,000. Given the positive correlation between a country’s level of economic development and its financial sector, we shall conduct sensitivity analyses for the classification of Eurozone countries as having or not a deep bond market.

8. The Ernst & Young report classifies jurisdictions to the deep/not deep groups based on countries’ data prior to 2013. Hence, we argue that the deep/not deep market countries should also be classified to their respective groups for the decade prior to 2013. We have tested this hypothesis by testing the effect of the sampled period on macroeconomic averages of the classified groups (for the periods of 2004-2006; 2007-2008 and 2011-2013) using ANOVA; the results show insignificant effect of the sampled period for all macroeconomic indicators.

9. The Eurozone countries are the following: Austria, Italy, Ireland, Estonia, Belgium, Germany, Holland, Greece, Luxembourg, Latvia, Malta, Slovenia, Slovakia, Spain, Portugal, Finland, France, and Cyprus.

C. The discriminating variables

To classify effectively between countries having or not a deep corporate bond market one must first identify some macro-economic indicators that proxy for market depth. Toward this end we use initially all, but eventually excluded a few of the indicators that Čihák et al. (2012) identify as proxies for ‘financial depth’. Their indicators include measures of financial institutions development and indicators for stock and bonds markets’ depth. For econometric reasons detailed below, we use a subset of their indicators. The economic content of the indicators we eventually use is detailed in the following section.

Indicators of financial institutions development

Liquid liabilities-to-GDP is considered an important indicator of financial depth. Liquid Liabilities, also known as M3 or ‘broad money’, is defined as the sum of currency and deposits in the central bank (M0), plus transferable deposits and electronic currency (M1), plus time and savings deposits, foreign currency transferable deposits, certificates of deposit, and securities repurchase agreements (M2), plus foreign currency time deposits, commercial paper, and shares of mutual funds held by residents. By Levine and Zervos (1998), this is the most comprehensive measure of a country’s financial activity, as it includes all the country’s financial intermediaries.

Financial system’s deposits-to-GDP is the ratio between total funds and savings deposited in financial institutions to GDP. Beck, Demirgüç-Kunt, and Levine (2010) consider this measure as a stock indicator of deposit resources available to the financial sector for lending activities, thus represents financial institutions’ funding liquidity.

A measure of stock market depth

Stock market turnover ratio is the ratio between the total volume of traded shares in the stock exchange and the market capitalization value of listed shares. Čihák et al. (2012) consider the turnover ratio as a measure of stock market efficiency since it measures trading activity, or liquidity, of the stock market relative to its size. Therefore, a small and active stock market should yield a high turnover ratio (more liquidity). We therefore expect to find a positive correlation between turnover ratio

and market depth.¹⁰

Measures of corporate bond market depth

Debt securities-to-GDP is the ratio between total outstanding local debt issued by private or public entities and GDP. This includes long-term and short-term bonds and short-term negotiable securities. We expect to find a positive correlation between the value of the bond market and financial depth because it is correlated with tradability. We distinguish between private debt (bonds issued by private firms) and public debt (governments, municipalities, etc.), therefore measure them separately.

Gross portfolio of debt assets to GDP is the ratio between total outstanding debt assets and GDP. We expect to find a positive correlation between total debt assets and financial depth. This is a new measure, available retroactively from 2004, and does not appear in Čihák et al. (2012).

D. Data

Our LDA analysis builds on the World Bank's GFDD dataset for all countries listed in table 1, and Israel as an exogenous observation, a total of 32 countries over the period from 2004 to 2011. Because the GFDD panel dataset contains time-series of macroeconomic indicators across countries, some indicators might exhibit serial correlation. Furthermore, the variance of some explanatory variables might vary over time, particularly during the highly volatile period of the global financial crisis. These properties undermine two assumptions in the LDA model: normally distributed explanatory variables, and independency of observations. To avoid those biases, we divided the database into three sub-periods: (1) the economic expansion period preceding the financial crisis (2004-2006); (2) the financial crisis (2007-2008); and (3) post-crisis recovery (2009-2011). In each sub-period we calculated the mean macroeconomic data for each

10. Čihák et al. (2012) also consider the stock market capitalization-to-GDP and stock market total value traded-to-GDP, which capture the size and activity of the stock market relative to the size of the economy. Nevertheless, Levine and Zervos (1998) and also Beck and Levine (2004) show that these measures are highly correlated, which is also evident in our database (correlation of 0.799). As a result, we chose to use the Turnover Ratio as a stock market measure of depth in order to avoid multicollinearity and potential bias in the LDA estimates.

country. This division controls for the varying levels of variance in each temporal cross-section and reduces serial correlations.¹¹ Furthermore, we eliminated outlier countries from the dataset to improve stationarity. Outlier countries were defined as countries with at least two records lower than the 5th percentile or higher than the 95th percentile for at least three different explanatory variables (for each of the two market depth categories, separately). The elimination process was performed iteratively by fitting the LDA model to the dataset, until the mean probability of classifying the countries converged. Countries with a mean probability of less than 50% were eliminated from the dataset (i.e., all three observations of the country were eliminated). After eliminating the outlier countries, the dataset contained data on six deep market measures for 28 countries and Israel, a total of 87 observations.

E. Goodness-of-fit measures and LDA procedures

Due to the asymmetry in the number of observations in countries with and without a deep market, we computed the prior probability of classification into the k th group empirically as the ratio between the number of observations in group k to the total number of observations in the sample. To avoid reducing the sample size at the classification stage due to missing data, we replaced the missing data with the most recent data for the same period and the same country. The classification is based on the linear discriminating function under the assumption of homogeneous variance-covariance matrices for countries with and without a deep market. This assumption is tested using the statistic Box's M, and if significant, the LDA is performed again under the assumption that the variance-covariance matrix differs by category.

Goodness-of-fit is tested using Wilk's lambda, which examines the difference between group means. Goodness of fit is also tested using a classification table that defines the model's success rate by summing the number, and percentage, of records that the model classified correctly compared to the initial classification of these records in the dataset.

It should be noted that a high classification rate does not ensure that

11. We performed several nonparametric tests on the LDA model assumptions to make sure our approach tackles the econometric issues effectively. We used a runs test to assure that the order of appearance of the observations is random. The Kolmogorov-Smirnov test was used to examine the normality assumption in both groups separately. We find that all variables are normally distributed, except for Gross portfolio of debt assets-to-GDP and Public debt.

good classification predictions are made for new records outside the dataset. Due to the small number of records, specifically for countries without a deep market, we did not divide the dataset into a training set and a testing set according to conventional practice. Instead, we preferred to test the model by cross-validating the original dataset using the ‘leave one out’ method.¹² This method enabled us to exclude each country when estimating its probability for inclusion in the two categories.

The LDA methodology proves powerful by identifying a few outlier countries: Australia, Slovenia, and Slovakia. Australia’s mean discriminant score turns higher than the score of deep-market countries, although it defined itself as not deep. Yet, in the past Australia defined itself as having a deep-market but revoked this definition, to the best of our knowledge due to disagreement between regulators. Nonetheless, some Australian firms, especially major importers, adopt IAS-19.

The discriminant scores for Slovenia and Slovakia are significantly lower than most countries having a deep market, although both are Eurozone members. Therefore, their pre-classification in the deep-market group evidently stems from their ability to operate in the deep markets of the Eurozone using the Euro, as IAS-19 requires that corporate bonds be issued at the currency of the local jurisdiction. In other words, the justification for their classification in the deep-market group is based on an accounting criterion, not on an economic criterion.

F. Descriptive statistics

The correlation matrix between all discriminating variables showed a high positive correlation between Financial system deposits-to GDP and Liquid liabilities to GDP (0.905). In order to avoid potential bias of the LDA estimators due to multicollinearity, we chose to remove Liquid liabilities-to-GDP from the sample. Table 2 presents descriptive statistics by groups of countries with and without a deep market, and for Israel.

One can readily see that the means and medians of all measures are higher in countries having a deep market vs. countries not having a deep market. Most of the Israeli data are closer to deep market countries data,

12. In the leave-one-out method, each observation is classified using the LDF that is estimated over the $n-1$ remaining observations in the sample. This procedure is performed for all the observations in the sample.

TABLE 2. Descriptive statistics

Variable Description	Statistics	Category		
		Israel	Deep market	No deep market
Financial systems deposits-to-GDP (%)	Mean	87.48	110.29	39.79
	Median	88.07	96.23	42.57
	SD	2.42	70.03	11.77
Liquid Liabilities-to-GDP (%)	Mean	97.68	122.06	70.35
	Median	97.81	105.15	51.67
	SD	4.22	69.48	51.02
Stock market Turnover Ratio (%)	Mean	56.58	95.75	68.07
	Median	56.36	99.9	47.86
	SD	3.21	67.51	51.08
Private debt securities-to-GDP (%)	Mean	18.69	41.01	12.2
	Median	18.86	34.81	13.73
	SD	7.48	26.62	7.49
Public debt securities-to-GDP (%)	Mean	41.74	46.86	30.39
	Median	40.64	41.18	31.66
	SD	2.73	34.21	10.3
Gross portfolio debt assets-to-GDP (%)	Mean	12.57	71.01	3.07
	Median	12.67	51.73	2.83
	SD	0.81	80.39	2.14
Number of Observations		3	72	12

with a few exceptions, like Stock market Turnover Ratio. In most other cases, Israel's scores are lower compared to deep-market countries, but higher than the typical indices for non-deep-market countries. These findings indicate that Israel's financial development measures are higher than those of non-deep-market countries, yet not in all parameters.

G. LDA model results

We implemented the LDA model on the macroeconomic data of the 28 sample countries (after excluding Australia, Slovenia, and Slovakia) over the three sub periods averages (subtotal of 84 observations) using a stepwise method in an attempt to find the best set of discriminating variables.¹³

13. We examined an alternative specification by using the ENTER method, in which all

TABLE 3. Analysis of Variance (ANOVA) tests of equality of group means

	F	df1	df2	Sig.
Financial system deposits to GDP (%)	24.779	1	66	.000
Stock market turnover ratio (%)	3.911	1	66	.052
Outstanding domestic public debt securities to GDP (%)	3.741	1	66	.057
Outstanding domestic private debt securities to GDP (%)	16.667	1	66	.000
Gross portfolio debt assets to GDP (%)	9.132	1	66	.004

Table 3 summarizes tests of equality of group means for all discriminating variables. As expected, ANOVA results show significant differences (at the 5% level) between means of the two market depth groups for all discriminating variables, except for the Turnover Ratio and Public debt-to-GDP (yet, both are close to be significant with p values of 0.052 and 0.057 respectively).

The strong statistical differences among the groups' means in Financial System Deposits-to-GDP and in Private Debt-to-GDP make them the most important and the only significant variables in the Linear Discriminant Function (LDF), which receives the form:

$$LDF = -3.196 + 0.021 \cdot \text{Financial Systems Deposits to GDP} + 0.033 \cdot \text{Private Debt Securities to GDP} \quad (5)$$

Table 4 shows how large is the difference between the discriminant scores of the Not-deep and Deep group centroids (-1.954 and 0.419 respectively). The Wilk's lambda test of the LDF in equation (5) is highly significant (p -value < .00). Further, classification results of the cross-validated data (without a table for space considerations) feature high classification accuracy for both the Not-deep group (91.7%) and the Deep-market group (95.7%), with overall predictive accuracy of 95.1%.

These results support the robustness of the LDA model, suggesting that it can be used to classify out-of-sample observations. Therefore, we use this LDF in order to explore whether Israel can be classified as a deep market country at the macro-economic level, and applied the same

discriminating variables are entered to the LDA model. We find that the results are similar in terms of significance of the discriminating variables, with lower estimation accuracy of the model (89.3%).

TABLE 4. Wilk's Lambda statistics

Deep Classifier	Group Centroids	Wilks Lambda	Chi-square	df	Sig.
Not Deep	-1.954	0.543	39.740	2	0.000
Deep	.419				

logic to estimate the probability of inclusion each country to the deep market group.

H. Out-of-sample classification of Israel and all other countries

The averages of the three sub-sample periods of Israel's data were entered to the *LDF* equation (5); this yields Israel's discriminant scores. Figure 1 shows the box plot of Israel's discriminant score versus the discriminant scores of the deep-market and not-deep-market groups of countries. It is evident that Israel is within the range of the deep-market group and above the upper bound of the not-deep-market countries. Specifically, Israel's discriminant score (-0.705) is far above the 95th percentile of the discriminant score of the non-deep-market countries (-2.014), and hence the probability that Israel belongs to the not-deep-market group is miniscule. Furthermore, notice that two observations of Luxembourg are between 1.5 and 3 times the interquartile range measured in the deep-market group. These outliers result from the fact that Luxembourg has a very highly developed banking system: its Financial system deposits-to-GDP was measured during 2004-2011 at 352% of GDP. We nonetheless retained Luxembourg in the sample as it does not have a significant impact on the classification function and therefore does not impair the classification of the remaining observations in the sample.¹⁴

In terms of the posterior probabilities obtained by the Mahalanobis distance between Israel's scores and the deep-market group centroid exemplified in table 4, we find corresponding posterior probabilities of 69%, 82% and 89% in the three sub-periods, respectively. We also find that the considerable increase in posterior probabilities are mainly

14. We tested another LDA model on the remaining countries in the sample, excluding Luxembourg. The classification function obtained was similar to the present classification function. Cross validation of the observations using the leave-one-out method also showed the same classification results.

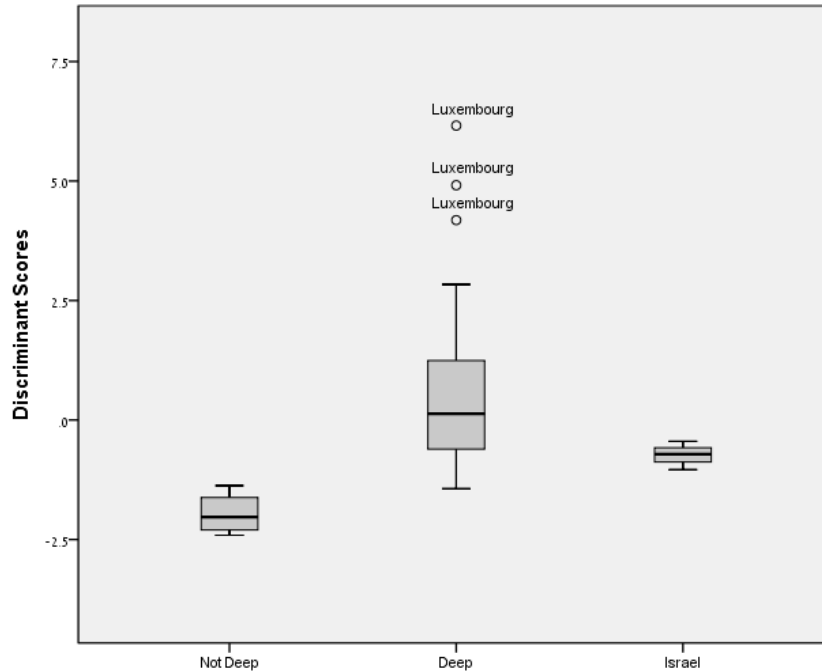


FIGURE 3.

Note: Israel's discriminant score versus the discriminant scores of the deep-market and non-deep-market groups over the three periods of the sample.

driven by a large increase in local debt securities-to-GDP, which more than doubled during the three sub-periods (11.13%, 18.86% and 26.09% respectively). Hence, the trend of deepening the local corporate bond market during 2004-2013, concurrently with a solid development of Israel's financial institutions, has a substantial effect on Israel's probability to belong to the group of countries with a deep-market in local corporate bonds market.

Table 5 presents the probability of classifying each of the countries in our dataset to one of the two categories, 'deep' or 'not deep'. In each of the tests, the specific country was treated as an out-of-sample observation. Probabilities are reported along the three sub-periods, and one can see that while Greece was pre-classified as belonging to the 'deep' group based on its membership in the Eurozone, the model finds that with higher probability Greece should have been classified as belonging to the 'not deep' group between 2004-2006. However,

TABLE 5. Probability of classification

#	Country	Prob. “deep” 2004-2006	Prob. “deep” 2007-2008	Prob. “deep” 2009-2011
1	Austria	0.950	0.979	0.988
2	Belgium	0.922	0.941	0.991
3	Canada	0.991	0.977	0.961
4	Cyprus	0.978	0.994	0.999
5	Estonia	0.674	0.744	0.823
7	Finland	0.555	0.605	0.691
8	France	0.897	0.950	0.979
9	Germany	0.960	0.965	0.968
10	Greece	0.455*	0.685	0.908
12	Ireland	0.997	1.000	1.000
13	Israel	0.690	0.817	0.890
14	Italy	0.687	0.798	0.936
15	Japan	0.999	0.999	1.000
16	Korea, Rep.	0.954	0.953	0.982
17	Latvia	0.625	0.657	0.714
18	Luxembourg	1.000	1.000	1.000
19	Malta	0.957	0.958	0.946
20	Netherlands	0.996	0.999	0.999
21	Norway	0.546	0.894	0.944
22	Portugal	0.882	0.967	0.997
23	Spain	0.947	0.997	0.999
24	Sweden	0.789	0.899	0.956
25	Switzerland	0.984	0.975	0.987
26	United Kingdom	0.829	0.832	0.818
27	United States	0.999	1.000	1.000
28	Brazil	0.369	0.527**	0.585**
30	China	0.304	0.356	0.542**
31	Mexico	0.177	0.190	0.238
32	Poland	0.138	0.161	0.205

Note: Probability of belonging to the “deep” group. * Pre-classified as “deep”, yet probability of belonging to “not deep” is higher. ** Pre-classified as “not deep”, yet probability of belonging to “deep” is higher.

starting in 2007 Greece was classified by the model as belonging to the ‘deep’ group with higher probability. In contrast, China and Brazil that were pre-classified as belonging to the ‘not deep’ group, improved in the macroeconomic measures and their probability of belonging to the ‘deep’ group increased over time: The model estimates that Brazil is more likely to belong to the ‘deep’ group starting in 2007, and China since 2009.

To summarize this section, by using the *LDF* we conclude that Israel

should be classified as a deep-market country based on high posterior probabilities to belong in the deep-market group. This result corresponds with increases in indicators of market depth in the local private bond market and in total deposits with financial institutions. Both indicators increased along the three sample periods, and the probabilities of being similar to the deep-market group increased respectively from 69% to 82% and to 89%. Absent a practical guideline to define whether a given jurisdiction meets the ‘deep market’ qualifications of IAS-19, we believe that this classification model can serve as an objective tool in answering this question, at this stage by the macroeconomic aspect only. In the following section, we add the second, microeconomic aspect.

IV. Requirement 2: The microeconomic aspect

In this section we use data of the Israeli bond market as a test case toward showing how one would examine a local market depth from the microeconomic perspective, i.e., based on the liquidity premium of local high-quality corporate bonds. To this end, we compare the local liquidity premium with that of the U.S. corporate bonds market, using Dick-Nielsen et al.’s (2012) methodology and findings. Theoretically, Duffie and Singleton’s (1999) model motivates a liquidity premium in corporate bond’s spread by the following equation:

$$R - r = PD \cdot LGD + Liq , \quad (6)$$

where R represents the corporate bond’s yield to maturity, r is a government bond yield of a similar duration, PD is probability of default, LGD is Loss Given Default (as percent from par), and Liq is the liquidity premium. The economic intuition is that the spread is the sum of credit risk, measured by $PD \cdot LGD$, and a liquidity premium.

A. Data

We obtained the dataset from Israel Securities Authority. It contains daily trading statistics for all senior and unsecured bonds traded in the local bond market between January 2004 and January 2014.¹⁵ Bonds in

15. The dataset does not include bonds with special covenants or attributes, such as convertible bonds, variable interest bonds, bonds indexed to currency rates, bond tranches,

the dataset are rated A or higher by the local representative of either S&P or Moody's. The dataset further incorporates all traded government bonds. Data fields include closing price, face value, adjusted face value, pre-tax yield to maturity, duration, market capitalization, daily trading volume (in the local currency), and categorical variables that describe the bond rating and sector. The sectors are CPI-indexed government bonds, not-indexed government bonds, CPI-indexed corporate bonds, and not-indexed corporate bonds.

Following Dick-Nielsen et al. (2012), we limit the sample to have bonds with trading activity of more than five days in a month and a trading volume of over 10,000 NIS (about \$3,200).¹⁶ By default, we use a bond's credit rating as given by S&P, but if missing we use Moody's rating. We convert ratings to numbers as follows: AAA=1, AA=2, A=3 (ignoring notches of '+' and '-'). Like Dick-Nielsen et al. (2012) we analyse bond spreads before and after the global financial crisis, but since our dataset ends well after the crisis, we define the same three sub periods as in the macro analysis: (1) the period before the financial crisis (2004-2006); (2) the financial crisis period (2007-2009); and (3) the recovery period (2010-1/2014).

We analysed both the CPI-indexed corporate bonds sector and the not-indexed sector, separately. Since we found that the not-indexed sector has a large illiquidity premium, we conclude that it cannot qualify as meeting the 'deep market' requirements. Note that while we concluded above that by the macroeconomic aspect the Israeli financial markets meet the deep market requirement, the not-indexed group is not defined as being deep because it does not meet both requirements, the macro and microeconomic aspects. Therefore, the remainder of this section presents our results with respect to the CPI-indexed group only.

B. Bond yield spread and explanatory variables

Following Dick-Nielsen et al. (2012), our dependent variable is the yield spread. The generic regression model often used in the literature

put or call options.

16. Similarly, Dick-Nielsen et al. (2012) filtered erroneous trades in order to prevent potential bias of liquidity premium estimates, while also excluding bonds with less than one month after issuance or before maturity. This filtering leaves us with 318,403 records of daily trading, of which 224,315 daily trading data of 245 marketable corporate bond series issued by 63 unique companies.

is of the following form:

$$Spread_{i,t} = \alpha + \sum_{j=1}^J \beta_j X_{j,t} + \varepsilon_{i,t}, \quad (7)$$

where $Spread_{i,t}$ is the yield spread of bond i in month t ; $X_{j,t}$ is a vector of $j = 1, 2, \dots, J$ explanatory variables with respective β_j regression coefficients, and $\varepsilon_{i,t}$ is the error term. The $X_{j,t}$ vector may include several bond specific measures (e.g. bond characteristics and liquidity measures), but not necessarily. Specifically, the yield to maturity is regressed against the following explanatory variables:

$$Y_{i,t} = \alpha + \beta_{i,TERM} TERM_t + \beta_{i,DEF} DEF_t + \beta_{i,RATE} RATE_{i,t} + \beta_{i,DUR} DUR_{i,t} + \beta_{i,Liq} IML_t + \varepsilon_{i,t} \quad (8)$$

We use monthly observations, where the monthly yield spread is a volume-weighted average of daily yield spreads. The first two explanatory variables follow Fama and French (1993), and the other explanatory variables are defined as follows:

$TERM_t$ is the mean difference between long- and short-term government bond yields in month t . Long-term average yields are those of bonds with durations above the 75th percentile, while short-term yields are of bills shorter than one year. $TERM_t$ proxies for unexpected changes in the slope of government bonds' yield curve.

DEF_t is the mean difference in yield to maturity between low credit rating corporate bonds and yields of comparable duration government bonds. DEF_t proxies for credit risk premium.

Bond rating ($RATE_{i,t}$), is the monthly average of daily rating score, thus bonds with missing ratings in a month are excluded from the sample. It is used to control for bonds' credit risk.

Mean duration ($DUR_{i,t}$), is the average monthly duration of bond i in month t .

IML_t is the mean difference in yields between illiquid corporate bonds minus that of liquid corporate bonds traded in month t . Our primary measure for illiquidity is the Amihud $ILLIQ$ measure (Amihud, 2002), which calculates the average ratio between the absolute daily return and daily trading volume for all trading days of month t . We use an adjusted measure, intended to account for non-stationarity and outliers (Karolyi et al., 2012),

$$ILLIQ_{i,t} = \frac{1}{N_{i,t}} \sum_d \log \left(1 + \frac{|R_{i,t,d}|}{VOL_{i,t,d}} \right), \quad (9)$$

where $N_{i,t}$ is the number of observed daily returns in month t for bond i , and $R_{i,t,d}$ and $VOL_{i,t,d}$ are the respective return and trading volume observed for bond i at day d within month t .

We calculate IML_t by first sorting the monthly illiquidity measure $ILLIQ_{i,t}$ for all bonds in the sample from high to low and split the sample to two equal groups. We then calculate the mean difference in yield-to-maturity between the high-illiquidity group and the low-illiquidity group. Thus, multiplying the beta coefficient of IML by its average value reveals the average illiquidity premium embedded in the bonds' yield. This value may be compared with the illiquidity premium of the U.S. corporate bonds.

C. Descriptive statistics

Since our primary focus in this paper is the liquidity premium, table 6 presents summary statistics of three different liquidity proxies ($ILLIQ$, trading volume, and zero-trading days). We add to the $ILLIQ$ measure these two indicative proxies in order to present a more comprehensive view of this important variable. The zero-trading days measure, due to Chen et al., (2007), computes the percentage of days in a month without trading activity. The summary statistics are based on averages of daily data between January 2004 and January 2014.

A significant rise in corporate bonds' market liquidity is evident by a significant drop in median $ILLIQ$, from 0.0132 in the pre-crisis period (2004-2006), to a mere 0.0023 in the post-crisis period (2010-2014). This result reflects an average price impact of 0.23% change per NIS 1 million transactions, which is lower compared to the median $ILLIQ$ in the U.S. as reported by Dick-Nielsen et al. (2012), as we show below.

TABLE 6. Descriptive statistics of liquidity proxies

Variable Description	Statistic	Corporate bonds			Government bonds		
		2004-2006	2007-2009	2010-1/2014	2004-2006	2007-2009	2010-1/2014
Mean <i>ILLIQ</i> (per NIS 1 million)	Mean	0.0235	0.0345	0.0121	0.0123	0.0022	0.0001
	Median	0.0132	0.0090	0.0023	0.0013	0.0000	0.0000
	SD	0.0446	0.0806	0.0272	0.0282	0.0088	0.0003
Mean daily trading volume (NIS millions)	Mean	2.08	2.85	2.63	24.39	70.38	74.39
	Median	0.91	1.49	1.47	7.68	45.08	62.37
	SD	3.40	3.99	3.67	35.27	81.19	58.80
Zero trading (%)	Mean	30.25	13.91	5.35	16.75	2.23	0.00
	Median	22.73	0.00	0.00	0.00	0.00	0.00
	SD	29.14	22.32	13.41	22.29	8.24	0.00
Number of records		1,407	3,898	5,404	1,746	1,265	1,551

Note: Means, medians, and standard deviations of Amihud's *ILLIQ*, trading volume, and zero trading days for all government and corporate bonds rated A or higher. Three sub-periods are presented: pre-crisis (2004-2006), financial crisis (2007-2008) and post-crisis (2010-1/2014).

A similar trend is found in the government bonds sector, where median *ILLIQ* drops from 0.0013 in the pre-crisis period to virtually zero in the post-crisis period, reflecting a negligible impact of trades on their prices.

The significant rise in the median trading volume of individual bonds also indicates that the Israeli market became deeper over time: government bonds' daily volume increased from a median of NIS 7.68 million in the pre-crisis period to NIS 62.37 million in the post-crisis period, while the median in the corporate bond sector grew from NIS 0.91 million to over NIS 1.47 million in the post-crisis period.

Considering the zero-trading measure, we find a significant decline in the mean percentage of non-trading days in a month across the three sub-periods, both for government bonds and corporate bonds. The latter also shows a sharp drop in median values: whereas in the pre-crisis period one half of the most active bond series (those with over 5 trading days per month) were not traded in more than 22% of the monthly trading days; in the post-crisis period there are almost no zero-trading days. For comparison, Dick-Nielsen et al. (2012) report a median zero trading of 60.7%, which is calculated in the U.S. OTC market. This measure highlights the liquidity of the Israeli corporate bond market, where, as noted, bonds are traded in a continuous order driven market, like stocks in most countries.¹⁷

To visualize the time-series trend of the deepening Israeli corporate bonds market, we compute the yearly averages of two liquidity measures, *ILLIQ* and zero-trading days, over the CPI-indexed bonds in the sample. Figure 4 shows the averages of Amihud's *ILLIQ* and zero trading measures, revealing a dramatic rise in trading activity and liquidity in this market. Zero-trading averages drop from 56.5% in 2009 to only 3.9% in 2013, with a modest increase in 2010-2011. We find an overall decline in *ILLIQ* from 0.0223 in 2004 to merely 0.0091 in 2013, with a temporal increase during the financial crisis (2007-2009).

D. The microeconomic aspect: Liquidity premium

This section examines the liquidity premium of all CPI-indexed corporate bonds based on the time-series regression of bond yields as in

17. Similar results are reported by Abudy and Wohl (2017) also show that the liquidity of the Israeli bonds is similar and even superior to the liquidity of several U.S. corporate bond classifications. They explain it by the active role that retail investors play in local bonds trading.

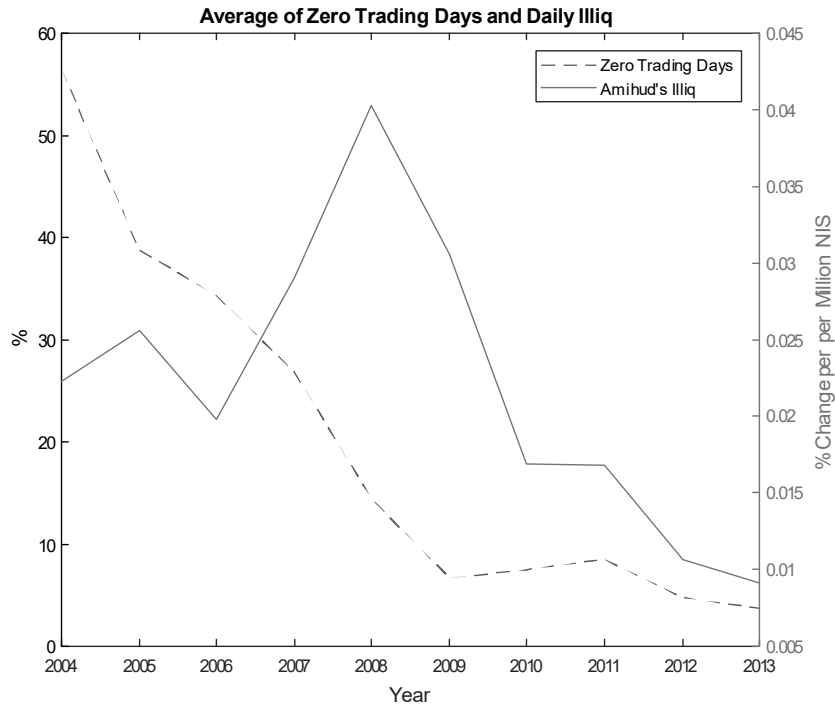


FIGURE 4.

Note: Time-series illiquidity measures between 2004 and 2013. Yearly averages of the monthly zero trading (%) and monthly *ILLIQ*, calculated by averaging across all CPI-indexed corporate bonds rated A or higher. Contains 8,419 monthly records of 183 CPI-indexed bonds.

the model of equation (8) above. The regression results are reported in table 7.

Table 7 presents the premiums for the factors that determine the yield to maturity of high-quality CPI-indexed bonds. Note that the sum of the premiums in each column makes the average yield to maturity for the sample period, 3.85% in the first subperiod, 5.67% in the second and 2.58% in the third subperiod. Of particular interest is the average yield to maturity of the HQCBs in the last period, which was 2.58%. This is of interest since the illiquidity premium in this period accounted for 6 basis points, and highly significant ($t = 2.37$). This finding represents a relatively low liquidity premium, which is rather similar to the premiums in the US, as we elaborate below.

Comparing this finding to the remaining periods in the sample shows

TABLE 7. Regression Results, Indexed Bonds

Variables Description	<i>t</i> -stat				Yield components			
	2004-2006	2007-2009	2010-1/2014	2010-1/2014	2004-2006	2007-2009	2010-1/2014	2010-1/2014
Intercept	1.46	-0.43	-10.2	-10.2	0.75	-1.22	-4.45	-4.45
TERM	-13.41	-3.69	-17.0	-17.0	0.26	-0.29	-0.58	-0.58
DEF	7.90	10.65	16.27	16.27	0.26	3.07	0.72	0.72
Bond Rating	1.79	-1.72	-5.13	-5.13	0.00	-0.03	-0.03	-0.03
Mean Duration	5.18	1.45	15.81	15.81	2.66	3.92	6.87	6.87
IML	-9.12	0.79	2.37	2.37	-0.11	0.2	0.06	0.06
Total Yield (%)	17.9	26.8	13.9	13.9	3.85	5.67	2.58	2.58
R ² (%)								

Note: Regression coefficients and respective *t* statistics of CPI-indexed, A and above rated corporate bonds. The dataset contains 2,379 monthly records of 51 indexed government bonds and 8,419 monthly records of 183 indexed corporate bonds issued by 59 companies, traded between January 2004 and January 2014. The sum of all yield components sums up to the total yield.

TABLE 8. Means of illiquidity measures by period and rating

Variables	Period	Corporate bonds							
		AAA	AA+	AA	AA-	A+	A		
Mean <i>ILLIQ</i> (change per NIS 1 million)	2004-2006	.0272	.0222	.0205	.0218				
	2007-2009	.0333	.0282	.0312	.0401	.0759			
	2010-1/2014	.0008	.0044	.0122	.0200	.0088	.0062		
Zero trading (%)	2004-2006	32.59	33.70	32.66	22.83				
	2007-2009	21.08	14.64	12.83	12.63	11.41			
	2010-1/2014	0.00	1.07	5.44	10.23	2.25	.03		
No. of records	2004-2006	90	510	330	303	0	0		
	2007-2009	471	491	1379	943	35	0		
	2010-1/2014	32	588	1216	1433	575	23		
Total records		593	1589	2925	2679	610	23		

Note: Monthly means of Amihud's illiquidity measure and percentage of Zero-trading days in the indexed sector. The dataset contains 8,419 records of 183 indexed corporate bonds issued by 59 companies and traded between January 2004 and January 2014.

that the illiquidity premium in the crisis period was 20 basis points, although not statistically significant. In contrast, the liquidity premium during the real estate boom (2004-2006) was negative. This negative sign contradicts our expectation for a positive difference in yields between the high and low halves of corporate bond yields sorted by illiquidity each month. A plausible explanation is that the average yield of bonds ranked 'high' by illiquidity was smaller than the yield of bonds ranked 'low' by illiquidity during the pre-crisis period. This may occur if the low illiquid bonds (i.e., actively traded bonds) received lower credit ratings than the high illiquid group by rating agencies. Indeed, before the financial crisis many real estate firms received low ratings, but they were popular by many investors and actively traded.¹⁸

To verify this explanation, we examined the mean illiquidity and zero trading measures over the monthly dataset for each rating category and sub-period. Table 7 shows that in the 2004-2006 period, mean illiquidity of bonds rated AA- was lower than the mean illiquidity of bonds rated AA+ (0.0218 and 0.0272, respectively), and that trading frequency of AA- bonds was also greater (zero trading 22.83% and 33.7%, respectively). As noted, this trend subsequently reversed in the following years, especially between 2010 and 2014, where trading frequency and liquidity increase as a function of bond rating. The lack of statistical significance of the impact of bond ratings on yield to maturity, together with the finding of greater trading volume in lower quality bonds in the A rating category is consistent with the sense of euphoria and disregard for risk that characterized the Israeli bond market in the period leading up to the crisis.

E. Comparative analysis

Once the liquidity premium has been computed, the relevant question is whether the segment of corporate bonds based on which the liquidity premium has been computed satisfies the IAS-19 requirements for being classified 'deep market'. To answer this question, we compare the Israeli liquidity premia along the three sub-periods to the premia measured in the U.S. market, probably the deepest market in the world,

18. The correlation between the explanatory variables generally did not exceed 50% and were mostly significantly lower than this figure. We also tested alternative hypotheses such as initial and final quarters as the explanatory factor for liquidity, weighted observations of market value for each bond, with and without eliminating outliers. The results were not significantly different from the findings reported here.

TABLE 9. U.S. liquidity rates before and after the financial crisis, in basis points

A: pre-subprime crisis (2005:Q1-2007:Q2)						
Rating	Liquidity Component (basis points)			Number of Observations		
	0-2 years	2-5 years	5-30 years	0-2 years	2-5 years	5-30 years
AAA	0.6	0.9	1.1	162	178	193
AA	0.7	1.0	1.3	704	667	498
A	1.5	2.5	3.2	1540	1346	1260
BBB	2.8	4.0	4.7	517	270	553
Spec	45.0	44.0	83.9	270	324	480

B: post-subprime crisis (2007:Q2-2009:Q2)						
AAA	2.5	4.5	79	110	149	155
AA	23.5	37.1	64.7	493	572	483
A	26.6	51.0	74.5	762	878	890
BBB	64.3	115.6	98.1	123	159	256
Spec	123.6	224.0	242.7	133	129	201

Note: U.S. liquidity component for each rating class and duration before and after the onset of the subprime crisis reported by Dick-Nielsen et al. (2012). The dataset contains US corporate bonds transactions from TRACE sampled between 2005:Q1 and 2009:Q2.

as reported by Dick-Nielsen et al. (2012).

Table 9 reproduces table 4 from Dick-Nielsen et al.'s paper, presenting the result of an analysis of 5,376 bonds traded on the U.S. OTC market. Similar to our sample, this sample does not include bonds having unique features that might affect pricing. Panel A shows the mean liquidity premia between Q1/2005 and Q1/2007, before concerns of the subprime crisis affected the financial markets. In Panel A, the liquidity premium on BBB-rated bonds, a rating that approximately corresponds to the Israeli rating of A, for maturities of more than five years, was 4.7 basis points (bp). Similar but shorter bonds (2-5 years) paid a liquidity premium of 4.0 bp, while A-rated bonds paid a premium ranging between 2.5 and 3.2 bp. Panel B shows that at the height of the crisis, between Q2/2007 and Q2/2009, the liquidity premium on BBB-rated bonds soared to between 98.1 and 115.6 bp, and in contrast to the remaining findings, the shorter bonds paid the highest premium. A-rated bonds paid 51-74.5 bp and even AA-rated bonds paid a liquidity premium of 37.1-64.8 bp, depending on years to maturity.

Table 10, which reproduces table 5 in Dick-Nielsen et al.'s paper, presents the liquidity premia component as a fraction of total spread.

TABLE 10. Pre-crisis and post-crisis liquidity premiums as a fraction of total spread

A: Liquidity component in fraction of spread, pre-subprime crisis (2005:Q1-2007:Q2)								
Maturity	0-1yrs	1-2yrs	2-3yrs	3-4yrs	4-5yrs	5-8yrs	8-10yrs	10-30yrs
Fraction in pct.	3	7	13	13	13	11	8	10
Number of obs.	1596	1613	1241	891	641	1187	578	1218
Rating	AAA	AA	A	BBB	Spec			
Fraction in pct.	3	4	11	8	24			
Number of obs.	533	1869	4148	1340	1075			
B: Liquidity component in fraction of spread, post-subprime crisis (2007:Q2-2009:Q2)								
Maturity	0-1yrs	1-2yrs	2-3yrs	3-4yrs	4-5yrs	5-8yrs	8-10yrs	10-30yrs
Fraction in pct.	11	20	23	27	31	44	33	43
Number of obs.	809	819	675	657	556	817	568	598
Rating	AAA	AA	A	BBB	Spec			
Fraction in pct.	7	42	26	29	23			
Number of obs.	414	1549	2533	539	464			

Note: U.S. liquidity component as fraction of the spread for each rating class and duration before and after the onset of the subprime crisis, as reported by Dick-Nielsen et al. (2012). The dataset contains U.S. corporate bonds transactions from TRACE between 2005:Q1 and 2009:Q2.

Panel A refers to the pre-crisis period, while Panel B refers to the crisis period. The liquidity premium is between 4% and 11% of the spread for bonds rated between BBB and AA in the pre-crisis period, but accounts for between 26% and 42% of the spread for similarly rated bonds in the crisis period.

The bottom line from the microeconomic perspective is that Israel can be considered a deep market based on the level of liquidity premium in the indexed HQCB sector between 2010-1/2014, which was 6 bp. Moreover, the Israeli liquidity premia in this period as fraction of the spread was 3.6% ($0.06/(2.58-0.92)$), as the average government bond yields was 0.92%, close to the lower bound of the fraction measured in the U.S. (4%-11%). The finding that the liquidity premium during the financial crisis period was 20 bp in this sector, compared with 98.1 and 115.6 bp in the U.S., indicates that the market was deep in comparison to the U.S. market. As it turns out, during the crisis, the Israeli market was more liquid than the U.S. market, probably because the U.S. market was the source of the crisis and the subject of investors' main concerns.

V. Conclusions

The accounting standard IAS-19 requires that a local market where high-quality corporate bonds trade be considered ‘deep’ in order to use their average yield as the discount rate for post-employment benefits. Otherwise, the relevant discount rate must be the average yield of government bonds. The difference between these two rates may be substantial. Yet, the term ‘deep market’ has two aspects: the macro-economic aspect, which measures funding liquidity, and the micro-economic aspect, which measures market liquidity. Because these two aspects are interconnected, such that if one liquidity dries-up the other dries-up as well, we argue that a market cannot be ‘deep’ unless both aspects are measured empirically, and the jurisdiction proves deep by both. Our major contribution is by being first to propose a uniform test across countries.

In this paper, we measure the macro-economic aspect based on the World Bank’s database of macroeconomic ratios between a group of countries held to have a deep market, and a group with no deep market. We take Israel as a case in point and use a discriminant analysis test to determine whether, based on its macroeconomic ratios, Israel can be classified into one of the two groups at high statistical significance. We extend the analysis and report macro-classification results for all 32 countries in our dataset, showing mis-classifications in some of the sub-periods for Greece, Brazil and China. The micro-economic test is performed for Israel only, again as a test case, using daily trading data of Israeli corporate bonds. The joint of these tests indicate on one segment of the corporate bond market as being ‘deep’.

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