

Corporate bond aggregates

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Abstract

The Bank of Israel regularly monitors activity in the Israeli bond market. The Information and Statistics Department maintains an information system with regard to securities traded on the Tel Aviv Stock Exchange, including tradable corporate bonds.

In order to monitor the range of corporate bonds and to analyze activity in this market, the Bank of Israel computes bond aggregates. Such an aggregate consists of a group of tradable corporate bonds sharing common features. Grouping bonds in aggregates allows for weighting of individual data to form a single benchmark representing the entire group, which may be used for analysis over time and comparison of the risk associated with market segments.

This document describes the major calculations for bonds—yield to maturity, margin and duration—and how these calculations are weighted to reach an aggregate benchmark representative of a bond basket, with reference to key methodology issues. This document presents major aggregates used by the Bank of Israel.

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1. Background and objective of this document

The corporate bond market brings together business companies that require financing for their operations and investors from the public and financial entities. The market for tradable corporate bonds on the Tel Aviv Stock Exchange has evolved in recent years. Many more companies have started to raise debt through bonds, and debt instruments have become more diverse. The market value was NIS 376 billion at the end of 2019.

The Bank of Israel monitors activity on the bond market in order to fulfill its roles, primarily in two areas: (1) Monetary policy management—the pass-through mechanism for interest rates and the reliability of policy; (2) Supporting stability of the financial system—monitoring debt owed by public companies, risk development and risk pricing in the market.

The Bank of Israel's Information and Statistics Department maintains an information system on securities traded on the Tel Aviv Stock Exchange, including tradable corporate bonds.

In order to monitor the range of corporate bonds and to analyze activity in the bond market, the Bank of Israel calculates bond aggregates. Such an aggregate consists of a group of tradable corporate bonds sharing common features. The key aggregates used by the Bank of Israel are industry baskets (such as for the banking industry or the trade and services industry) and rating baskets (such as the AAA rating group and the A rating group). Grouping bonds in aggregates allows for weighting of individual data to form a single benchmark representing the entire group, which may be used for analysis over time of the risk associated with a specific market segment and comparison of different market segments.

The objectives of this document are to present the aggregates calculated by the Bank of Israel and the underlying methodology thereof, and to demonstrate their use through key products. This document includes a description of the major calculations for bonds—yield to maturity, margin and duration—and how these calculations are weighted for bond aggregates. This is done with reference to key methodology issues.

2. Aggregate calculation methodology

A. Weighting individual data for aggregate value

The Bank of Israel's Information and Statistics Department maintains an information system with regard to securities traded on the stock exchange, including tradable corporate bonds. This information is used, *inter alia*, for calculation of bond aggregates.

The aggregate value of each bond aggregate for each trading day is calculated by the weighted average across all individual data for each of the bonds in the aggregate. The weighting assigned to each bond is based on its market value on each trading day.¹

¹ Market value, yield, margin and duration for each bond are calculated based on the closing price thereof, as determined by the stock exchange upon closing of each trading day.

Following are key calculations applied to all corporate bonds:

- **Yield to maturity (YTM):** Yield to maturity is the average annual profit from investment in a bond, reflecting the profit that would be derived from holding it from the calculation date through final maturity, including all expected receipts.² The yield to maturity of a bond is a key benchmark used by market investors to evaluate the bond and the feasibility of investing in it. For unindexed bonds bearing a fixed rate of interest, the calculated yield is nominal; for CPI-indexed bonds, the calculated yield is real.
- **Yield margin:** Yield margin is the difference between yield to maturity of the corporate bond and that of a corresponding Government bond, i.e., similar in linkage and in average duration. This margin reflects the risk premium for the corporate bond over the corresponding risk-free yield on the local market, as represented by the yield for Government of Israel bonds. At the Bank of Israel, the yield margin is calculated relative to the Zero-curve model³ (a model for yield curve estimation), which estimates the yield curve for Government bonds.
- **Duration:** A bond's duration represents the average time remaining through debt repayment. Duration is calculated through weighting the duration for each principal and interest payment throughout the bond life by the amount of each payment, discounted using the yield to maturity.

The weighted yield and the weighted margin and duration are calculated for each aggregate.

For more information about these calculations, see Appendix 1.

B. Treatment of outlying observations

Occasionally, bonds may trade at a very high yield. This occurs when there is uncertainty with regard to solvency of the issuer and the probability of default on the bond has increased. Because yield sensitivity to price increases as the price declines, and with higher uncertainty comes significantly lower price, some bonds may sometimes record very high yield values.

The objective of the aggregate baskets is to calculate the aggregate yield and margin, so as to reflect the risk level for a group of bonds similar in their underlying attributes, in order to monitor risk for the group as a whole. Weighting outlying values of individual bonds may, under certain circumstances, skew the aggregate value for the basket, making it non-representative and not properly reflecting the risk level for the group, due to being disproportionately affected by outlying values.

Conversely, excluding such bonds from aggregates would reduce the number of bonds in the aggregate, causing the aggregate calculations to reflect a smaller group, and not reflect the uncertainty associated with some bonds in the group.

² Yield to maturity is the interest rate which, if used to discount the expected flow of receipts (principal and interest payments), would result in a present value exactly equal to the bond's price on the market – this calculation is based on Makeham's formula. This discount rate is the "internal rate of return".

³ For more information please see: Brodesky, Ana and Nadav Steinberg (2011). "Improving the Yield Curve Estimation Model Implemented at the Bank of Israel", (in Hebrew) Bank of Israel periodic article series, 2011.01.
https://www.boi.org.il/he/Research/Pages/occasional_pp1101h.aspx

Therefore, in order to calculate and present reliable indicators that reflect the risk associated with the group, we apply a mechanism⁴ that reduces the effect of outlying observations on the overall basket. This allows us to include more bonds in the basket and to reflect the uncertainty associated therewith, while also proportionately reflecting even very high yields.

C. Bonds included in aggregates

The objective of the aggregate baskets is to monitor developments and risk for groups of bonds sharing common attributes. To this end, we developed multiple criteria, designed to create bond groups that are as homogeneous as possible in terms of their underlying attributes. This is designed to mitigate, in as much as possible, the effect of factors such as uncertainty with regard to future receipts, as well as that of assumptions and estimates used in calculating the yield to maturity.

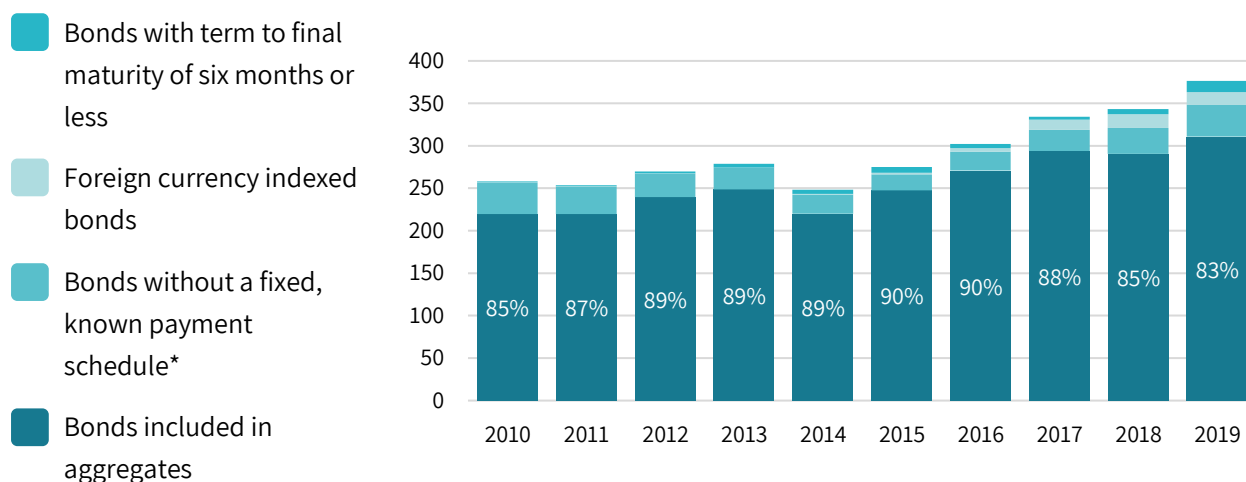
Major criteria for inclusion of bonds in baskets are as follows:

- **Bond types and interest types:** Baskets contain bond with a fixed, pre-determined stream of receipts, i.e., bonds bearing a fixed rate of interest, with no option components.⁵
- **Indexation types:** Most of the bonds issued and traded on the stock exchange are CPI-indexed or nominal (unindexed). Each basket contains either nominal bonds or CPI-indexed bonds, but not a mix of these two types. Thus, for example, there are two different baskets for the real estate industry—Real Estate CPI-indexed and Real Estate unindexed. For nominal bonds, the calculated yield is nominal; for CPI-indexed bonds, the calculated yield is real.
As can be seen in Figure 1, bonds indexed to foreign currency form a small, non-material group on the stock exchange in Israel, and therefore are not included in any aggregates.
- **Time to maturity:** The baskets include bonds with time to final maturity of six months or longer. This is because the sensitivity of yield to maturity to price fluctuations is higher as the time to maturity is shorter; moreover, the formula for yield to maturity of CPI-indexed bonds includes assumptions, the effects of which are also more significant for shorter terms to maturity.

⁴ The mechanism currently applied for treatment of outlying values is cutting off values based on fixed threshold values. Yields higher / lower than these threshold values are assigned the threshold value for the aggregate calculation. Currently applied thresholds are as follows: Maximum value: 100%; Minimum value: -5%. The thresholds are determined at the Bank of Israel's discretion and may change from time to time, and the same applies to the method for eliminating / reducing the effect of outlying observations.

⁵ Bonds with no option components – bonds classified by the stock exchange under the following sub-types: Ordinary corporate bonds, capital notes and obligatory notes. Sometimes, companies may issue complex debt instruments that include other risk elements, beyond the risk level determined based on issuer robustness, maturity and collateral provided to investors. In such debentures, the cash flow from holding the security is not certain and pre-determined, but rather depends also on market conditions and on other indicators. Calculating the expected profit from buying and holding such securities requires making multiple assumptions, and this small group is not material and non-representative. Therefore, such securities are not included in aggregates.

Figure 1: Bonds included in aggregates out of the total tradable corporate bond market
Market value, NIS billion, year end



* Structured bonds, convertible bonds, capital bonds for write-off or conversion issued by commercial banks in Israel (COCO – contingent convertible bonds), tradable securities and ordinary bonds bearing variable-rate interest.

Figure 1 shows that the calculated baskets cover most of the corporate bond market. The coverage rate at the end of 2019 was 83 percent.

D. Update of aggregate composition

The Bank of Israel calculates three major aggregate types for corporate bonds: Industry baskets, rating baskets and baskets based on major Tel Bond indices of the Tel Aviv Stock Exchange (hereinafter: "the Stock Exchange").

The composition of bonds in each basket is determined at the closing of each trading day, based on bonds actually traded on that day, and in conformity with the sector classification, series rating and composition of Tel Bond indices as known on that day. Therefore, basket composition may change from day to day, such as due to new bonds that start being traded or change to rating of any bond.

A bond may be included in multiple baskets simultaneously: For example, CPI-indexed bonds of a company in the TASE's banking sector rated AAA and included in the Tel Bond 60 Index, would be included in four baskets: Banking sector – CPI indexed; Rating AAA – CPI indexed; basket based on composition of the Tel Bond 60 Index; and all CPI-indexed corporate bonds.

Baskets in use incorporate a significant group of bonds, both in terms of the number of bond series and in terms of their total market value. Historical depth varies among baskets, and the list of baskets may change from time to time due to changes to the number of series in each basket and their total market value, and at the Bank's discretion.

Table 1 lists the attributes of major aggregates calculated by the Bank of Israel's Information and Statistics Department.

Table 1: Major aggregates of corporate bonds

Indexation	Aggregate name	Market value (NIS billion)	Number of series included in basket	Yield to maturity	Margin	Duration (years)
		Monthly average, December 2019				
CPI-indexed	CPI-indexed A	33.4	70	1.0%	1.9%	3.3
	CPI-indexed AA	100.7	106	0.2%	1.0%	4.4
	CPI-indexed AAA	42.3	22	-0.3%	0.5%	3.9
	CPI-indexed – banks	60.4	43	-0.3%	0.6%	2.8
	CPI-indexed – real estate and construction	82.8	132	0.8%	1.6%	4.5
	Tel Bond 60	116.5	60	0.1%	0.9%	4.4
	Total – CPI-indexed corporate bonds	185.5	231	0.6%	1.4%	4.0
Unindexed	Nominal A	45.0	121	4.4%	3.6%	3.4
	Nominal AA	41.6	70	2.3%	1.4%	4.2
	Nominal – insurance	11.8	25	2.5%	1.3%	5.5
	Nominal – banks	15.2	13	1.4%	0.5%	3.5
	Nominal – trade and services	15.6	37	3.5%	2.6%	3.8
	Nominal – real estate and construction	46.8	162	5.2%	4.4%	3.4
	Tel Bond Nominal	102.4	158	2.4%	2.1%	3.7
	Total – Nominal corporate bonds	128.5	337	3.1%	2.7%	3.6

3. Key outputs of bond aggregates

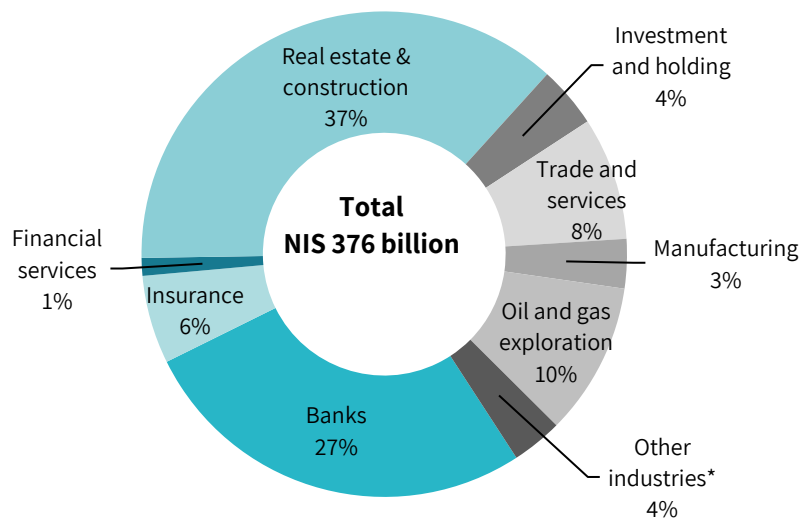
The three main features of bonds used for market segmentation are as follows: TASE sector – type of business activity of the issuer, as reported by the Tel Aviv Stock Exchange; bond rating – the risk of default, as published by rating agencies; key features listed in the bond prospectus, primarily interest type (fixed or variable) and debt indexation terms.

A. TASE sector aggregates

The companies traded on the Tel Aviv Stock Exchange (TASE) are classified by the Stock Exchange under sectors⁶ upon their IPO, or in case of material change in the company's business. The sector classification takes into consideration the description of company business and the composition of revenues, assets, market value and shareholder equity of the company and any subsidiaries and associates thereof.

In addition to sector baskets, we also calculate two baskets for all corporate bonds, containing bonds from all sectors: All CPI-indexed corporate bonds and all unindexed corporate bonds.

Figure 2: Distribution of market value of corporate bonds, by major Tel Aviv Stock Exchange sectors, December 31, 2019



* Structured bonds, technology and biomed.

⁶ For more information, see the Stock Exchange sector classification procedure at: https://info.tase.co.il/Heb/listings_ipo/sector_classification/Pages/sector_classification.aspx

As can be seen in Figure 2, about two thirds of the corporate bond market is currently focused on the TASE's financial sector and on the real estate and construction sector, with values of bonds in all other sectors being significantly lower. Recent years have seen debt issuance by public companies in the technology and biomed sectors, the leading high-tech sectors in the domestic economy; however, due to the start-up nature of these companies and the relatively high risk associated therewith, the total public debt raised by these companies is not very large.

Figure 3: Yield margins for nominal bond aggregates, by Tel Aviv Stock Exchange sector
Percent, monthly average

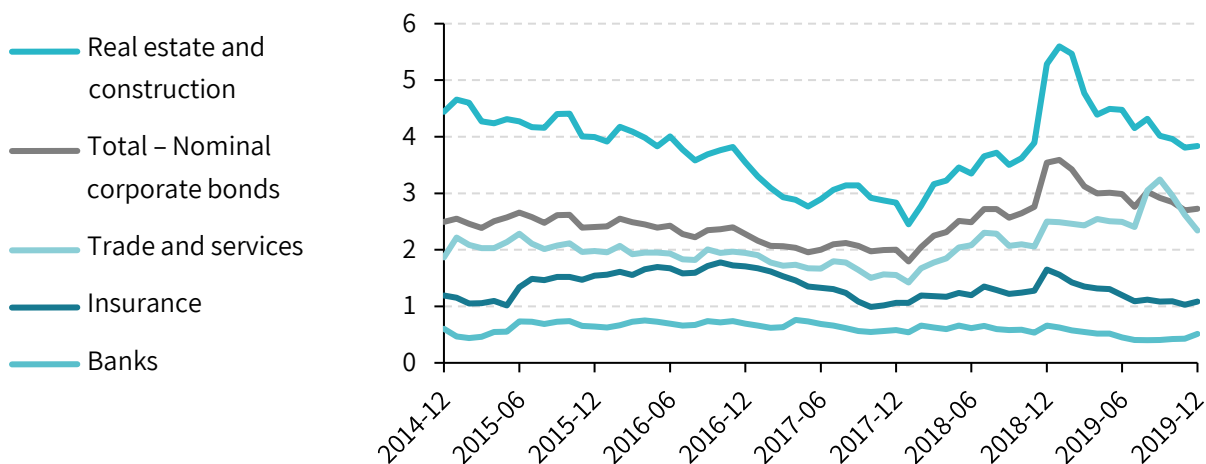


Figure 3 shows the risk level in the bond market by TASE sector. This would indicate that the lowest margins are in the banking sector, at 0.5% at the end of 2019, compared to an average of 3% for all CPI-indexed corporate bonds of all sectors⁷.

It is important to note that the various aggregates do not have homogeneous attributes: Each aggregate contains bonds of different ratings, capital and duration, and therefore the aggregate baskets also differ in total capital, weighted average duration and so forth. Therefore, a complete margin and risk analysis requires reference to all attributes of each basket as well.

B. Ratings aggregates

Israeli bond series are rated by two rating agencies operating in Israel: "Maalot S&P" and "Midroog". The domestic credit rating constitutes a forward-looking expression of opinion with regard to creditworthiness of the issuer with regard to a specific bond series. This compares with creditworthiness of other financial obligations of Israeli and foreign debtors active in the domestic financial markets. The rating agencies regularly monitor the rated series and revise their ratings from time to time.

⁷ Includes sectors not listed separately in Chart 3.

Table 2: Ratings aggregates – grouped by rating scales of local rating agencies

Rating aggregate calculated by Bank of Israel	Bonds included based on Maalot rating	Bonds included based on Midroog rating
AAA	AAA	Aaa
AA	AA+	Aa1
	AA	Aa2
	AA-	Aa3
A	A+	A1
	A	A2
	A-	A3
BBB	BBB+	Baa1
	BBB	Baa2
	BBB-	Baa3
Below BBB	BB+	Ba1
	BB	Ba2
	BB-	Ba3
	B	B1
		B2
		B3
	CCC	Caa1
		Caa2
		Caa3
	CC	Ca
D	C	

Domestic rating categories range on a scale from AAA ("Maalot") or Aaa ("Midroog"), which are the highest ratings, to D ("Maalot") or C ("Midroog"), which are the lowest ratings and denote default. Each rating agency has its own symbols for the rating categories, and the symbols are parallel to each other, as is customary in the market. We grouped the categories into rating aggregates that reflect distinct risk groups—see Table 2.

**Figure 4: Distribution of market value of corporate bonds by rating group
December 31, 2019**

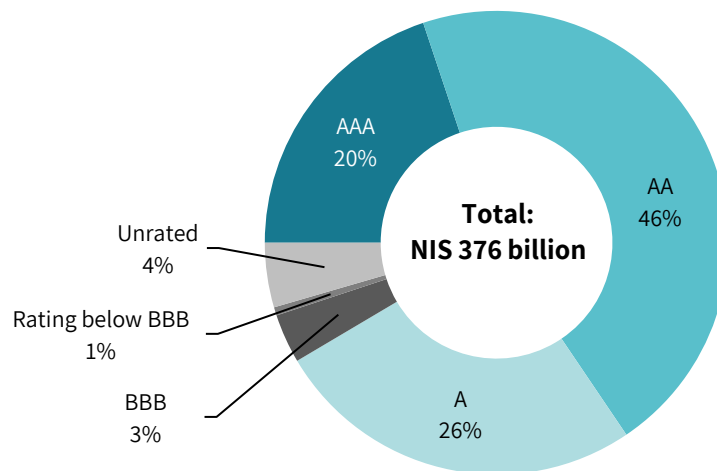


Figure 4 shows that rated bonds account for 96% of total market value, of which one fifth are assigned the top rating of AAA. The top three ratings – AAA, AA and A – account for 92% of the market.

**Figure 5: Yield margin for CPI-indexed bond aggregates, by rating groups
Percent, monthly average**

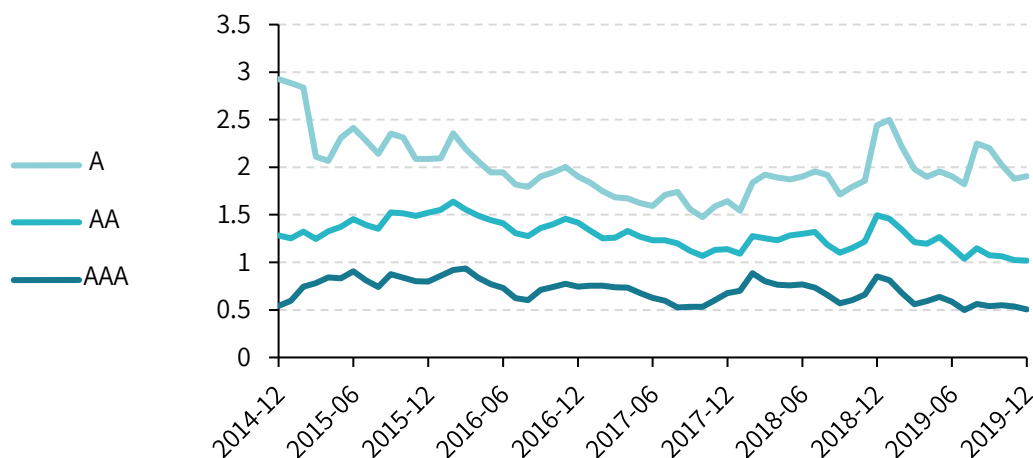


Figure 5 shows that the aggregate margin for the AAA basket is the lowest, reflecting the lowest risk level in the market. All other rating groups depicted in this Figure have higher margins, reflecting higher risk levels.

C. Aggregates based on bonds included in Tel Bond indices⁸

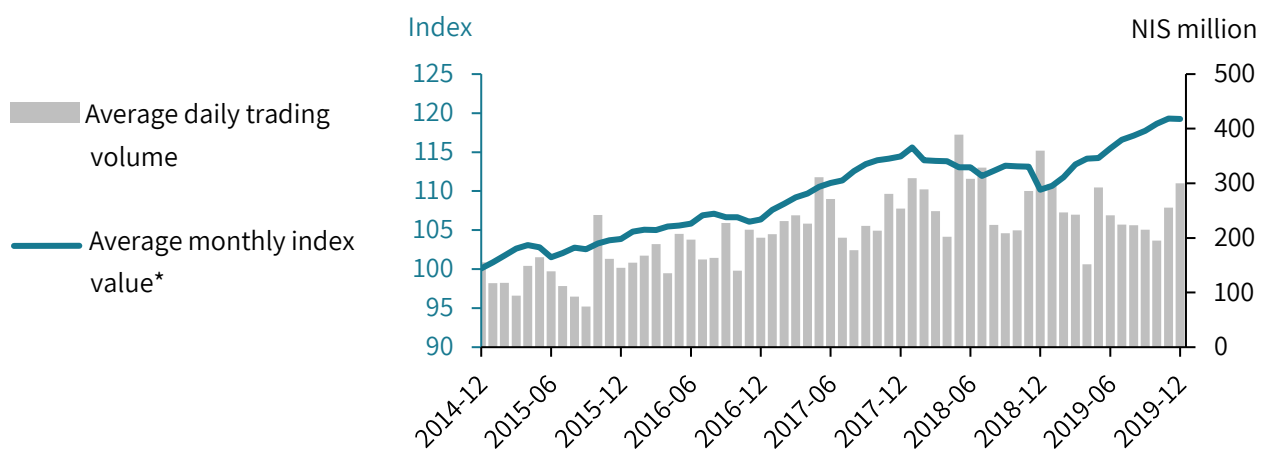
The Tel Aviv Stock Exchange groups bonds traded on the Stock Exchange into Tel Bond indices, in order to calculate an indicator representing the prices of bonds included in each group. Tel Bond corporate bond indices were first launched in February 2007 and this index series has been expanded since then. Calculation of an

⁸ For more information about Tel Bond indices, see the Stock Exchange website:
https://info.tase.co.il/heb/knowledge_center/indices/pages/overview.aspx

indicator to represent prices of bonds in the group is relevant for trading of these indexes; the aggregates calculated by the Bank of Israel are not designed for trading purposes, but rather for monitoring market risk, hence they present aggregate calculations of margin, yield and duration.

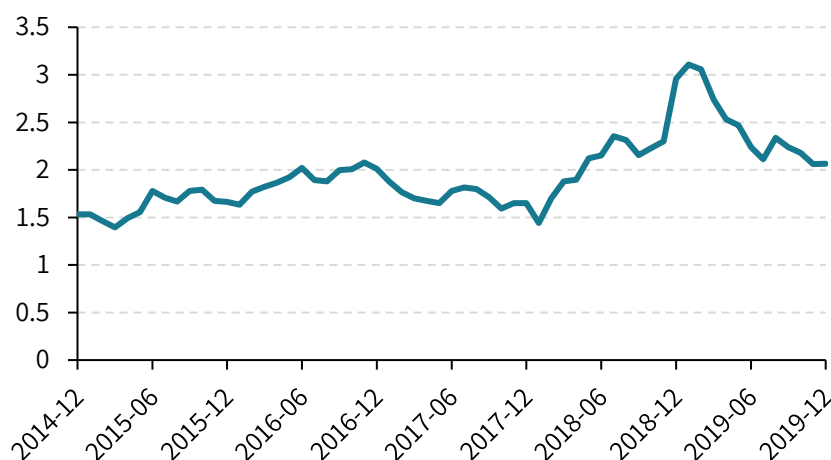
Figure 6 shows key attributes that are relevant for trading the Tel Bond nominal index: The value of this index, as determined by the Stock Exchange, as well as trading volumes, are used as one of the parameters for investing and trading in this index. Concurrently, Figure 7 shows the margin for the basket based on the Tel Bond nominal index, representing the risk level of bonds included in this index.

Figure 6: Tel Bond nominal index and trading volumes for bonds included therein
Monthly average



* Index, December 31, 2014 = 100
 Source: Stock Exchange

Figure 7: Aggregate margin of aggregate based on Tel Bond nominal index
Percent, monthly average



Appendix 1: Specific calculations for corporate bonds

A. Yield to maturity

Bond yield calculation is based on IRR formula, adjusted for inflation:

$$P = \sum_{n=1}^N \frac{CF_n}{(1+i)^{t_n}} M_n$$

Where:

i – Yield to maturity – calculated as equation solution.

P – Bond closing price.

N – Number of future expected payments for bond, based on the current repayment schedule.

CF_n – Expected flow of principal and interest payments for the n payment.

t_n – Duration in years until the n payment.

M_n – For CPI-indexed bonds, this is the inflation adjustment for the n payment, which includes, *inter alia*, the base CPI for the bond and the known CPI upon the calculation date; for nominal bonds $M_n = 1$.

B. Yield margin

At the Bank of Israel, the yield margin is calculated relative to the zero-curve model⁹ which estimates the yield curve for Government bonds. This model calculates the nominal and real risk-free yields for each term to maturity on the Government bond yield curve, allowing for calculation of the yield margin for each corporate bond:

$$Mar = \begin{cases} i - ZCN(Dur), \text{ Nominal bonds} \\ i - ZCR(Dur), \text{ CPI - indexed bonds} \end{cases}$$

Where:

i – yield to maturity, as calculated in Section A above.

Dur – duration, as calculated in Section C below.

ZCN – nominal zero curve yield as a function of the duration.

ZCR – real zero curve yield as a function of the duration.

C. Duration

$$Dur = \sum_{n=1}^N \frac{t_n \cdot CF_n}{(1+i)^{t_n}} \cdot M_n \cdot \frac{1}{P}$$

Where:

Dur – Calculated duration.

⁹ For more information please see: Brodesky, Ana and Nadav Steinberg (2011). "Improving the Yield Curve Estimation Model Implemented at the Bank of Israel", Bank of Israel (in Hebrew).

N – Number of future expected payments for the bond, based on the current repayment schedule.

CF_n – Expected flow of principal and interest payments for the n payment.

t_n – Time in years until the n payment.

M_n – For CPI-indexed bonds, this is the inflation correction for the n payment, which includes, *inter alia*, the base CPI for the bond and the known CPI upon the calculation date; for nominal bonds $M_n = 1$.

i – yield to maturity, as calculated in section A.

P – Bond closing price.