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Israeli Treasury Auction Reform[1]

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Israeli Treasury Auction Reform

By

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Abstract

This study uses a unique proprietary database in order to investigate the results of the 2006 reform in which primary dealers were introduced into the Israeli Treasury securities market. The study compares the results of the treasury auctions before, during and after implementation of the reform. The study uses an intra-day database for analyzing the effect of the reform on liquidity, in addition to the full demand and winnings database of each auction. The data enables us to test the result of the reform on the bond market and to measure the cost of government financing by presenting a number of measures for the auction premium We show that after allowing for other relevant variables, the price in the auction, relative to the price in the secondary market at the same time, declined by as statistically significant extent due to the reform. We also show that the uncertainty-related variables which we investigated have a negative effect on the auction premium—but only after the reform, while before the reform there was no effect. We show that while the auction premium was declined as a result of the reform, the dynamics of the price changes in the secondary market around the auctions changed significantly.

רפורמת מכרזי האג"ח הממשלתיות

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תקציר

מחקר זה משתמש במאגר נתונים ייחודי כדי לחקור את ההשפעות של הכללת עושי שוק ראשיים במסחר באג"ח ממשלתיות, פרי הרפורמה שהתבצעה באג"ח הממשלתיות בשנת 2006. בעבודה זו הושוו תוצאות מכרזי האג"ח לפני, במהלך ואחרי יישום הרפורמה. המחקר משתמש בנתוני מסחר תוך-יומיים כדי לחקור את ההשפעה של הרפורמה על מדדי נזילות, בנוסף לנתוני הביקוש והזכייה של כל אחד מהמשתתפים בכל מכרז. מבנה נתונים זה מאפשר לנו לבחון את ההשפעות השונות של הרפורמה ולמדוד את עלות המימון הממשלתית על ידי הצגת מספר חישובים של פרמיית המכרז. מתוצאות המחקר עולה כי בעקבות הרפורמה המחיר במכרז ירד באופן מובהק ביחס למחיר בשוק המשני, זאת לאחר שבודדו ההשפעות של כל משתני השוק הרלוונטיים. עוד נמצא כי למשתני אי-הוודאות/התנודתיות בשווקים ישנה השפעה שלילית על פרמיית המכרז רק לאחר הרפורמה בעוד שלפניה לא הייתה למשתנים אלה השפעה כלל. מתוצאות המחקר עולה כי בעוד שפרמיית המכרז ירדה כתוצאה מהרפורמה, התפתחות המחירים בשוק המשני בחלון הזמן סביב שעת המכרז השתנתה באופן דרמטי.

1. Introduction

In 2006, primary dealers were introduced to the Israeli Treasury securities market as part of a series of reforms introduced by Israel's Ministry of Finance. This study investigates the effect of the reforms on both the auction results and on liquidity in the secondary market.

The fact that market microstructure has an important effect on market activity, liquidity and pricing, has been established in financial and economics literature.[1] Moreover, the idea that the introduction of market makers to the market for a particular security may have an important pricing effect has been researched in the context of secondary markets. For example, Silber (1984) investigated voluntary market makers in the futures markets in the United States. Eldor, Hauser, Pilo, and Shurki (2006) investigated the effect of the introduction of market makers to the liquidity and efficiency of options trading in electronic markets in Israel. Montalvo (2003) investigated the introduction of market makers during a short period of trading in Spanish Government Bond Futures traded on the MEFF (Spanish Futures Market Exchange). Gamrasani (2011) examines whether the reform in Israeli government bonds succeeded in increasing the liquidity of the secondary market. Gamrasani's (2011) results indicate that, although the reform did improve market activity, it did not improve either liquidity costs or market depth.

This study contributes to the study of market microstructure as it focused on the initial sale of the securities in the primary market—the Treasury auctions. Specifically, the study investigates how activity and prices at auctions changed as a result of the introduction of market makers in both the primary and the secondary markets. Treasuries auctions in Israel and many other countries are the largest primary markets in their locale. Most countries (including Israel) use such auctions to issue debt (Brenner, Galai and Sade (2009)). Given the recent financial crisis and the growing worldwide need for government bond issues to raise additional debt, understanding the effect of market makers on the Treasury auction mechanism has potentially significant practical implications, in addition to the academic significance.

[1] Early works include Demsetz (1968) and Amihud and Mendelson (1986) among others.

The reform that introduced designated market makers in Israel provides an opportunity to conduct an empirical event study. Our analysis is based on a unique proprietary database that was provided by the Bank of Israel for this research.

The main empirical question that we investigate in this research is whether this reform has in fact succeeded to reduce the cost of financing government debt. We present several measures for auction premium and discount. We show that allowing for other relevant variables, the closing price in the auction increased significantly after the reform. Another important question regarding the reform concerns the development of the price in the secondary market around the auction dates. We show that there has been a material change in the dynamics of this development before and after the reform. In particular, we see that the secondary prices tend to gradually increase as the auction day nears. Immediately following the auction date they tend to increase even more.

In addition to analyzing the impact on price, we assess the demand curve derived from the bids submitted to the auctions—we estimate both its elasticity and the level of aggressiveness of the participants in their demands. We also show that the number of participants is significantly and positively related to the size of the auction premium only after the reform. Most of the uncertainty variables are negatively related to the size of the premium.

The paper is organized as follows: Section 2 provides institutional details on the market structure and the reform. A detailed survey of literature is included in Section 3. Section 4 presents the data investigated in this research. In Section 5 we estimate the auction premium, the level of participation and the elasticity before and after the reform. In Section 6 we investigate the changes during the auction days in the secondary market price. Section 7 presents the conclusions.

2. The Israeli Treasury Securities Auction Reform

The Israel Ministry of Finance (MOF, or Treasury) instituted a series of reforms in the government bond markets for the purpose of increasing liquidity and efficiency and reducing the cost of its debt. Many of the reforms were enacted in 2006. On June 19th, 2006, the responsibility for the management of bond issues and the back office moved

from the Bank of Israel to Israel's Ministry of Finance.[2] As a result of that change, Bloomberg supplied a platform for conducting Israel government bond auctions. Previously, auctions were held via a designated system, *Shva*, which was used only by local participants. One of the reasons for changing to an international platform was to enable foreign participants to take part in government auctions in a simple and transparent manner.

Before the reform the MOF prescribed periodic discriminatory (pay-your-bid) auctions. These auctions were open to banks, large financial institutions and members of the Tel Aviv Stock Exchange. Individuals and corporations could participate in the auction via intermediaries. The secondary market for these securities was the Tel Aviv Stock Exchange, which also served as a clearing house. The daily trading volume in government bonds on the Tel Aviv Stock Exchange (in NIS million including MTS[3] and OTC) before and after the reform were–

2005, NIS 1,078 M[4];

2006, NIS 1,280 M;

2007, NIS 2,098 M.

The reform introduced designated primary dealers (PD) to the Israeli bond market. The initial group of primary dealers included 19 large, stable financial institutions that committed to quote bid and ask prices for large[5] series of government bonds. Eight of them were international banks, and eleven were Israeli banks and non-bank TASE[6] members. When the primary dealers system was launched, a new trading platform also began to operate—the Inter-Dealer System, in which primary dealers operate and are obligated to provide quotes on a regular basis (so the primary dealers are functioning as market makers as well). EuroMTS (MTS), the leading European developer of inter-dealer trading infrastructures for government bonds, developed the platform for trading among primary dealers. MTS is used for trading government bonds in several European Union countries, including Italy, Germany, France, Spain, and others. MTS began operating in Israel on September 4, 2006.

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[2] http://www.finance.gov.il/debt/gen/docs/rep0607_full.pdf
[3] MTS provides the wholesale electronic trading system for a number of fixed income markets, including Israel government bonds.
[4] At the time the exchange rate was aapproximately NIS 4 to one US dollar.
[5] Nominal bonds with fixed coupon, with over NIS 4B notional, and at least one year to maturity.
[6] Tel Aviv Stock Exchange.

The secondary market has changed since the reform was implemented. Before the reform, there was a single trading venue, the TASE, where close to 100 percent of trading took place. Since the reform, a significant amount of trading has been conducted via the MTS system. In addition to these changes in the secondary market, the designated market makers undertook to conduct a minimum volume of activity in the primary market.

The primary market auctions used the same pricing rule before and after the reform—the discriminatory price mechanism.[7] Since the introduction of the reform the participation rules in the auction system have changed. The Treasury decided to conduct two types of auctions: The first type is for primary dealers only, and the second type is open to the participation of primary dealers, banks and other TASE members. Since the reform, 80 percent of the new nominal fixed coupon bonds issued have been sold to the participating primary dealers only (first type); the remaining 20 percent are open (second type).

The reform also introduced a "green shoe option" to the auction system: Auction winners may purchase up to 15 percent of the face value amount that they purchased in the auction, at the auction's average price. Primary dealers that serve as market makers on the TASE can get an additional 3 percent at that price. Another improvement is the possibility of paying for the bonds purchased in the auction through the TASE Clearing House, which collects the funds from each participant and transfers them to the Ministry of Finance.

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[7] From treasury publications: Towards the end of the month preceding the month of the auction, an announcement is published stating the auction date and the series and quantities offered for sale. On the day of the auction, participants submit the requested quantity of each bond at each price through their terminals. Participants are permitted to change their bids without restriction until the deadline for bid submission. The last bid submitted by each participant by the deadline is binding. Auctions are conducted using a graded ("discriminatory") auction model: Immediately after the deadline for submitting bids, the auction closes to further bids and the system allocates bonds based on the prices offered, from the highest price to the lowest price, until all the bonds on offer are sold. The closing price is the price obtained at the point at which the full offered quantity is sold. All participants who offer a price higher than the closing price receive all the bonds they requested, and each bidder pays the prices bid in the auction. In the case of surplus demand at the closing price, a pro-rata allocation of the remaining bonds is carried out, according to the quantity requested by each participant at that price. At the end of the auction, each participant receives details of their winning bids as well as general data about the results of the auction, such as the quantity sold, average price and closing price. A summary of the auction results is also released to the public, on the website of the Government Debt Management Unit in the Accountant General's Division and through the Bloomberg system.

3. Literature Survey

The effect of liquidity on the price of bonds, that is, the size of the liquidity premium,[8] has been widely documented. Amihud and Mendelson (1991) compare the price of zero coupon US Treasury bills to Treasury notes with an equal term to maturity. They find that bills bear a lower yield to maturity than the notes, due to greater liquidity. Warga (1992) compares bond portfolios comprised of bonds from the most recent Treasury auctions in each time category ("On the Run") with equal duration portfolios comprised of bonds from older auctions ("Off the Run"). As "On the Run" bonds are generally more liquid then "Off the Run" bonds, this constitutes a good measure of the liquidity premium. Warga finds that the Off the Run bonds are priced to return a premium of 0.55 basis points per annum over the On the Run bonds of equivalent maturity. Houweling, Mentink and Vorst (2005), use nine different liquidity proxies to compare bonds while controlling for interest rate risk, credit risk, maturity, and rating differences between bonds. The proxies are: the amount issued, whether the bond is listed in an exchange, whether the bond is denominated in euros or in a legacy currency (Deutschmarks, Francs, et al.), whether it is on the run, the age of the issue, days in which the price does not change, yield volatility, number of dealers and yield dispersion. With the exception of listing, all proxies are found to produce a robust liquidity premium. A comparison of the proxies finds little difference in their effects.

Amihud and Mendelson (1980) present a model in which a monopolist market maker provides liquidity in the form of quoted bid and ask prices. The size of the bid-ask spread offered by the market maker is dependent on it's exposure to inventory risk. The model explains that price auto-correlation could be explained by the market maker's effort to mean reversion its inventory, which creates price pressure against its position.

Foucault, Kadan and Kandel (2005) present a dynamic model for liquidity provision in a competitive limit order market. Their model shows that such a market can achieve two distinct equilibria - when patient investors outnumber impatient investors, the market will exhibit small spreads with large gaps between quotes on the same side of the order book (in both sides); when the opposite occurs, the market exhibits a large bid-ask spread and small gaps between quotes on the same side of the order book. The article shows

[8] The term "Liquidity Premium" is used in this article to denote the increase (or decrease) in a bond's price due to high (low) liquidity. The term is also used in bond literature to denote the price difference between short and long duration bonds. The latter interpretation will not be used in this article.

that the small spread equilibrium is characterized by a higher net utility than the large spread equilibrium. Of importance to our work, the article stipulates that the introduction of market makers into the limit order market could maximize utility by moving the market from large spread equilibrium to small spread equilibrium.

Venkataraman and Waisburd (2007) test the effects of market makers in a limit order market. They do so by employing an event study analysis on data from the Paris Bourse, which allows low liquidity firms to choose whether to appoint unprivileged market makers. Venkataraman and Waisburd examine the effect of such appointments on firm liquidity and value in comparison to benchmark firms that did not appoint a market maker. They find that appointing firms enjoy a robust abnormal return of about 5%. Nimalendran and Petrella (2003) used a similar procedure to study the market structure of the Italian stock exchange to examine the effect of the introduction of market makers on liquidity. They find that the introduction of market makers led to an improvement in several measures of liquidity measuring both liquidity width and depth. While these papers are important in establishing the effect of market makers on liquidity and price, both of them differ considerably from our own; they deal with low liquidity equity rather then relatively high liquidity bonds, and they also focus exclusively on the secondary market.

Related research to ours is Albanesi and Rindi (2000), who examine the effects of the 1994 reform in the Italian government bond market. The 1994 reform included the introduction of primary dealers with market making obligations. Albanesi and Rindi do not use an event study methodology, which our paper does, and instead use a microstructure model of price formation, and estimate the VAR representation of the model. Albanesi and Rindi find that the 1994 reform was followed by an improvement in market quality in the form of decreased autocorrelation. Our study expands beyond Albanesi and Rindi's research, as it also examines the price effects of the introduction of primary dealers, as well as analyzes its influence on the primary market.

Keloharju, Nyborg and Rydqvist (2005) examine the demand schedule of primary dealers in Finnish government uniform price bond auctions for evidence that bidders use monopolistic power to create underpricing in the fixed auctions in comparison to existing issues. They test whether bidders adjust their demand function in response to changes in competition. They did not find such a connection, and conclude that underpricing cannot be explained by monopolistic behavior. They attribute this result to the strategic behavior

of the Finnish central bank, which adjusts the size of the issue even after the bids have been submitted. This creates a repetitive game dynamic in which the central bank can credibly threaten the primary dealers if it identifies monopolistic behavior.

The demand of the primary dealers which is affected by the bond return volatility has been widely documented in the literature. Keloharju, Nyborg and Rydqvist (2005), claim that the only variable found to be significant in the first statistical moment of the underpricing was the volatility[9]. Nyborg, Rydqvist and Sundaresan (2002), who examined discriminatory Swedish bond auctions, also found bond return volatility to be positively correlated with underpricing. Keloharju, Nyborg and Rydqvist (2005) claim that this does not necessarily imply that the bidders are risk averse (i.e. this does not reflect the bidder's ability to hedge against interest rate risk). Rather they attribute the volatility effect to the perceived presence of private information and the bidder's fear of a Winner's Curse.

4. Data and Sample

We have data on 123 auctions that occurred during 2005–2007 (before, during and after the reform). We focus on bond series that were already traded in the secondary market. This provides us with a price benchmark. 54 of these auctions were conducted before the introduction of the primary dealer reform and 69 auctions took place after the reform. Some of the auctions which were conducted after the reform (43 out of 69) were available only to primary dealers (first type), while others were open to all intermediaries and the public, which submitted orders via intermediaries (second type).

Our data was obtained from several data bases: We used both public auction information and the proprietary auction database obtained from the Bank of Israel. We used intra-day bond prices in the secondary market that were obtained from the Tel Aviv Stock Exchange and data on the use of green-shoe and repo transactions.

The proprietary data which we received from the Bank of Israel includes the demand of each bidder and the bidder's classification in the system (foreign versus local, bank versus broker and large institution versus small institution). We can thereby construct the full demand and winning curve for each submitting bidder (that may represent several

[9] The number of participants and expected size of the auction were found to be positively correlated with the skewness of the underpricing.

bidders who decided to submit their bids via one institution) and each type of bidder. In addition we have proprietary data that allows us to construct the full demand curve. The full demand curve data is not available to the public. The study was conducted using unique and detailed data that we were able to test and examine in detail in order to arrive at a best estimate of the reform's effect on the issue auction market.

Table 1 provides summary statistics relating to our sample. On average, bonds valued at NIS 366 million were offered per auction before the reform. Since the reform, the average bond value offered has been NIS 438 million per auction. The treasury offered larger quantities, NIS 492 million on average, at the auctions that were designated only for the primary dealers, compared with NIS 340 million which it offered on average at the auctions that were open for participation of the public.

Before the reform, an average (per auction) of 19 different bidders submitted bids directly to the auction. After the reform, the number of bidders at the auctions open to the public (second type) averaged 21.

5. Estimating the Auction Premium and Elasticity

5.1 Estimation of the Auction Premium

The quality of the treasury auction process is often evaluated by comparing the price received in the auction to the price of the same security on the secondary market.

One of the advantages of our unique research is that for many of the auctions that occurred during the period studied, the bond had already been traded on the secondary market. This enables us to compare the price in the auction to several different benchmarks in the secondary market. We define

$\text{Premium}_{i,t} = \text{benchmark}_{i,t} - \text{minimum winning price at the auction}_{i,t}$

Where:

i - the auction

t - the time of the auction

We used the following benchmarks in our calculations:

- The closing prices on the Tel Aviv Stock Exchange on the last trading day before the auction.

- The closing price on the Tel Aviv Stock Exchange on the same day the auction was held.[10]

- The average price (based on transactions) at which the security traded at approximately[11] 11:00 on the Tel Aviv Stock Exchange. (This is the time when participants submit orders to the auction.)

- A series of average prices based on the transactions on the secondary market at every trading hour during a period beginning three trading days before the auction date and ending three trading days after the auction.

Table 1 and Figures 1 and 1a-d summarize our findings. Before the reform, the price in the secondary market declines before the auction, and immediately after the auction the price goes back to the same level it was at before the declined. Thus, the cumulative auction premium is NIS 0.15, on average (Figure 1a). After the reform, however, there is a very large difference between the auctions open to the public and those open to primary dealers only. Thus, it is important to distinguish between the public auctions and the auctions which are exclusively for primary dealers. In the primary dealer auctions, although the auction premiums fell slightly on average, the price dynamic still behaves in the same way it behaved before the reform, but the lowest price is 24 hours after the auction time—the green shoe time. Thus, the cumulative auction premium is higher, reaching NIS 0.25 on average (Figure 1d). Interestingly, the biggest local banks, which are all primary dealers, could utilize the green shoe option the most, out of all the primary dealers. In the public auctions, although the auction premiums were close to zero and even negative, the intra-day price changes in the secondary market were positive and monotonic around the auctions. In particular, the cumulative change in the 7 days around the auctions is NIS 0.5 on average (Figure 1c).

We also test the significance of the price changes in the secondary market around the auctions, and compare the result with the non-issued series (Table 3). Thus, the test was implemented for four categories: before and after the auctions, for the issued series (on-the-run) and for the control group of non-issued series (off-the-run). The main finding of

[10] The closing price mechanism on the Tel Aviv Stock Exchange changed on July 29, 2007, from a closing price that was based on the average of a number of the most recent transactions to either a closing price based on the result of the closing auction, if there is sufficient volume, or to the average of a number of the most recent transactions if the sufficient volume rule was not met.
[11] From 10:30 to 11:30.

this test is that there is a significant price change in the secondary market only for the issued series, while the reform only slightly reduces the magnitude of the change for the issued series.

Other interesting findings: The intra-day standard deviation of the price changes in the secondary market is higher in the primary dealer auctions than in both the auctions before the reform and in the public auctions after the reform. The differences between the average and winning price in the primary dealer auctions are relatively high, which indicates that these auctions were more tense and under uncertainty about the winning prices.

5.1.2 What Affects the Auction Premium/Discount?

The auction premium which we use is the price in the secondary market at the time the participants submitted their orders in the auction minus the price in the auction. We estimated what may affect the premium.

$$SDA11:00_{t,i} - WP_{t,i} = C + B_1 \times STDEV\_BI_t + B_2 \times PD_t + B_3 \times PD_t \times Duration_{t,i} + B_4 \times NoPar_{t,i} + B_5 \times \ln(Capital) + B_6 \times \ln(DTS) + \Sigma_{t,i}$$

Where:

SDA11:00 – is the secondary market's price of the same issued serial.[12]

WP is – this is the minimum winning price at the auction.

- PD – this is a dummy variable that receives the value "1" if the auction is restricted to primary dealer participation alone.[13] The PD dummy variable is significant relative to the auction premium.

- Duration – The duration of the auctioned bond at the time of the auction. We use this variable to investigate the potential effect of the liquidity premium at the auction. One of our findings is that the duration effect exists only in the auctions that are open to the primary dealers alone.

[12] The price is estimated based on all the transactions between 10:30 and 11:30.

[13] We found that the auctions before the reform and the auctions after the reform that are open to the public have similar characteristics. This is why the dummy variable that receives the value "1" if the auction was conducted after the implementation of the reform is estimated to be the same as the PD dummy.

- NoPar – Number of participants, as a proxy for competition. Consistent with economic intuition, the number of players is significantly and negatively related to the size of the premium.

- STDEV_BI – The standard deviation of bond index changes (for 15 trading days before the auction)—as a proxy for uncertainty in the fixed income market. The STDEV_BI has significant and extensive effects on the auction premium only in auctions after the reform.

- Capital – the amount issued as a proxy for the liquidity premium in the market for the series offered in the auction.

- DTS – The bid amount in the auction relative to the offer amount, as a proxy for the demand pressures in the markets.

- Another two variables were estimated but found to be insignificant when estimated together with the STDEV_BI. The two variables are:

1. Absolute value (high-low price) of the day before the auction—as a proxy for uncertainty over the true price.

2. Number of days before the 15^{th} of the month (this or next)—as a proxy for uncertainty over the inflation rate. (The Consumer Price Index—CPI is announced in Israel by the Central Bureau of Statistics on the 15^{th} of each month.)

To summarized, controlling for other relevant variables that can affect the premium at the auction, the auction premium has a significant negative correlation with the reform. It should be emphasized that the uncertainty variable is negatively correlated to the size of the premium only after the reform. This result can be explained by the fact that after the reform the auctions become more attractive relative to the secondary market. The result of the estimations is shown in Tables 2.

5.2 Bidding Parameters and Estimating the Elasticity

The elasticity of demand gives the percentage change in quantity demanded in response to a one percent change in price (all other determinants of demand being constant) $(\Delta q/Q)/(\Delta p/P)$. In order to investigate the elasticity of the demand for a financial asset, we need the full aggregate demand curve. The elasticity in financial auctions was previously investigated in the financial literature mainly with respect to

equity. For example, Bagwell (1992) examines a sample of 31 share repurchases. Kandel, Sarig and Wohl (1999), investigate a sample of 27 Israeli IPOs sold in a uniform auction. Liaw, Liu and Wei (2001) estimate the elasticity of 52 Taiwanese IPOs sold via a discriminatory auction and Kalay, Sade and Wohl (2004) estimate the elasticity of demand and supply of equity at the opening stage of trading on the Tel Aviv Stock Exchange (call auction).

We calculate the elasticity at each auction in our sample as follows:

$$\eta_{ik} = [(\Delta q_{itk}/Q_{it})/(\Delta p_{itk}/P_{it})]$$

Where:

t is the date on which the auction was held,

i (1,2,..) is auction number i,

k (1,2,..) indicates the specific change in quantity which we estimate the elasticity (for example +/-5 percent, +/-10 percent, +/-25 percent, +/-50 percent),

P_{it} is the closing price of auction i on day t,

Δp_{itk} is the difference between the price resulting from the quantity change and the auction price on day t,

Δq_{itk} is the change in quantity for which we estimate the elasticity,

Q_{it} is the number of bonds offered in auction i on date t.

We calculate the mean elasticity for the total sample in the auctions before and after the reform. Figure 2 summarizes our findings. The reform affected the elasticity mainly in the direction of a decrease in quantity and had practically no effect at all in the direction of an increase in quantity. We found that the reform led to a lower elasticity of demand.

Since under the reform, certain auctions were open to primary dealers only, we wished to investigate whether the documented change takes place in all new auctions or only in auctions open to the public (second type). To clarify this we calculated the mean elasticity for the total sample versus the mean elasticity in the auctions that were designated for primary dealers only. Table 4 summarizes the results of the average

elasticity before and after the reform. From this table we can see that the reduction of the elasticity of demand derived mostly from the auctions open to primary dealers only.

From the bidding parameters—in addition to the elasticity of demand—we can learn that the strategies of participants in the auction have been changed due to the reform. The spreads weighted by the quantities of the bidding prices increased considerably, mainly in the auctions open to the public, but also in the primary dealers' auctions. It is interesting to note that the local primary dealers increase their spreads in the primary dealer auctions but the foreign primary dealers increase their spreads in the public auctions. The detailed results appear in Tables 6, 7 and 7a.

6. Measuring Liquidity

One of the most important aims of the reform was to increase the liquidity in the secondary market. Gamrasani (2011) estimated the effect of the reform on liquidity in the secondary market and argued that although the reform did improve market activity, it neither reduced liquidity costs nor increased market depth.

In this paper, we examine the liquidity changes around the auctions and test for structural changes. In particular, we examine the effect of the auctions on the liquidity in the secondary market using different acceptable measures (volumes, bid-ask spread (BAS), intra-day standard deviation (std), and market depth). We test these measures on the Israeli bills *(makam* - securities of up to one year) as a control group. The results are presented in Tables 5a–5e. After the reform there is improvement in all of the liquidity measures in the secondary market on the auction day itself and on the day after. This improvement is significant in comparison to other days. On all other days, the bid–ask spread increased dramatically and it is hard to explain this finding with increased risks, since the bid–ask spread on the auction day and on closed days stays similar to those days before the reform. When we test the bid–ask spread in finer resolution we find that during the hours before the auction and at the time of the auction itself the bid-ask spread decreased only after the reform. Figure 3 summarizes our findings. This shows that the reform increased the liquidity in the bond market, and dramatically stabilized the BAS only during the trading period which was close to the auctions. An additional important change which took place is that the BAS became much more stable after the reform, which can be seen very clearly in the lower graph of Figure 3.

Another interesting finding relates to the effect that the offering amount in each auction has on the trading volume, as seen by comparing the data before and after the reform. Prior to the reform, there was no relationship between the amount offered at the auction and the volume of trading. After the reform, we found that the volume is affected by the amount offered, not only on the same day but also on the four trading days around the auction. Figure 4a and 4b summarize our findings.

7. Conclusions

As stated, the reform implemented by the Israel Ministry of Finance in the government bond market reduced the cost of debt. We document that the reform indeed had an impact. However we indicate some problematic developments regarding the dynamics of the price changes in the secondary market.

We summarize our findings below.

1. Lower cost of debt:

The main conclusion of this study is that the cost of the government's debt was reduced as a result of the reform. The reform led to higher auction prices that were closer to the intra-day price in the secondary markets at the time of the auctions. This is a positive indication that the reform was successful. However, before the reform and in the primary dealer auctions after the reform, there was a consistent increase in bond prices on the stock exchange immediately after the bonds were issued or immediately after the green shoe, respectively. This increase indicates that the prices prior to the auction were relatively low, prompting an increase in the prices in the secondary market, meaning a higher cost of debt for the government.

2. Increased liquidity:

The secondary bond market became more liquid following the reform even though the majority of the bonds issued were limited to a small number of primary dealers only. As a result of the reform, international financial intermediaries became active in the Israeli bond market.

3. Reduction and stabilization of the BAS:

The BAS became smaller as a result of the reform, particularly in the days immediately preceding the auction. In addition, the BAS became far more stable after the reform.

4. Change in elasticity in the demand curve:

We find that the elasticity measured in a quantitative decrease declined as a result of the reform. Both before and after the reform we found the elasticity to be more sensitive to a quantitative decrease than a quantitative increase.

5. Bond prices increased in the secondary markets following closed auctions: In the auctions that were held for primary dealers only and were closed to other market participants, we found that there was an increase in bond prices in the secondary market in the hours after the auction. This raises the question of whether there was a deliberate price manipulation on the part of market players.

6. The connection between the trading volumes and the offering amounts: Before the reform there was no clear connection. Higher offering amounts did not necessarily lead to higher trading volumes. However, after the reform we found a clear correlation, where higher offering amounts led to higher trade volumes in the secondary market.

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Table 1
Descriptive Statistics

This table describes the quantities offered and demanded, the number of participants and awardees and the auction premium. The auction premium is defined as the return of the winning price or the average price relative to the last day close, just before the auction time, and the same day close. In the after period—the table shows the use of the green shoe option on average, and the use of the loan facility. (* 10 percent significant, ** 5 percent significant, *** 1 percent significant – the difference between its value and the equivalent value before the reform)

Auction Characteristics	**Secondary Offering**			
	All Auctions		Auctions for PD only	Auctions for the public
Mean (*Median)* [STD]	Before Reform N= 54	After Reform[1] N=69	After Reform N=43	After Reform N= 26
Total Quantity Offered In millions	366 (350) [67]	438 (400) [194]	498 (450) [207]	340 (350) [119]
Total Quantity Bid In millions	3,028 (1,627) [3,222]	2,566 (1,811) [3,725]	2,900 (1,748) [4,626]	1,989 (2,017) [857]
PDC - Winning Price	0.07 (0.09) [0.236]	0.09 (0) [0.421]	0.11 (0.11) [0.307]	0.07 (-0.01) [0.568]
SDA 11:00[2] - Winning Price	0.075 (0.061) [0.150]	0.047 (-0.007) [0.207]	0.085 (0.157) [0.229]	-0.02*** (-0.016) [0.116]
SDC - Winning Price	0.17 (0.15) [0.173]	0.06*** (0.03) [0.317]	0.04** (0.03) [0.376]	0.08** (0.03) [0.188]
PDC - Average Price	0.02 (0.075) (0.230)	0.03 (-0.02) [0.392]	0.03 (-0.01) [0.273]	0.03 (-0.03) [0.542]
SDA 11:00[2] - Average Price	0.028 (0.038) [0.137]	-0.012* (-0.04) [0.172]	0.009 (-0.032) [0.193]	-0.048*** (-0.041) [0.10]
SDC - Average Price	0.12 (0.109) [0.180]	-0.004*** (-0.01) [0.320]	-0.03*** (-0.04) [0.378]	0.04** (0.015) [0.185]
No of participants	19.2 (19.0) [1.8]	17.0 (16.0) [4.6]	14.2 (15.0) [2.6]	21.5 (21.5) [3.3]
No of awardees	13.2 (15.0) [4.7]	9.4 (8.0) [7.0]	8.4 (8.0) [5.4]	11.0 (10.0) [9.0]
Used TAMAM[3] /green shoe option (percent)	0.90 (1.00) [0.27]	0.398 (0.196) [0.431]		

PDC – Previous Day Close price; SDA11:00/SDC –Same Day at 11AM price/Close Price

[1] Between 19/6/06 and 18/9/06 the reform was partial: The auctions were on the Bloomberg platform and the PD list was known but no formal obligations were apparent.

[2] Only one outlier observation is deleted—20/11/06 (second auction of a new series).

[3] TAMAM—a request for an increase in the issue amount at the average interest rate which had to be submitted before the results of the auction were announced.

Table 2

Linear Regression: Auction Premium

Dependent Variable: SDA 11:00 - Winning Price

	All Auctions	Before Reform	After Reform
C	1.04**	0.42**	1.54**
STDEV_BI	-0.7**	-	-0.76**
PD	-0.24**	-	-0.19**
PD*Duration	0.017**	-	0.018**
NoPar	-0.018**	-0.012*	-0.016**
Ln(Capital)	-0.02	-	-0.05*
Ln(DTS)	-0.06**	-0.09**	-0.04*
R2	0.37	0.33	0.41
Mean Dependent Var	0.006	0.025	-0.011
N	122	54	68
D.W.	2.02	1.74	2.12

* indicates 5 percent significant, and ** indicates 1 percent significant

SDA11:00 –Same Day at 11AM prices
STDEV_BI - Standard deviation of the Bond Index price changes
PD – Dummy for Primary dealer actions
NOPAR – number of participations in the auction
Capital – the amount of issued
DTS – Demand to Supply

Table 3
Intra-day Price Changes

This table provides a statistical description of the intra-day price changes for issued and non-issued bonds, before and after the reform.

Intra-day Price Changes—between 11:00 and 15:00

Issued Series before the Reform		*Non-Issued Series before the Reform*	
Mean	0.042	Mean	0.001
Standard Error	0.031	Standard Error	0.014
Median	0.065	Median	0
Standard Deviation	0.228	Standard Deviation	0.16
Sample Variance	0.05	Sample Variance	0.027
Kurtosis	1.80	Kurtosis	3.38
Skewness	0.08	Skewness	-0.67
Minimum	-0.53	Minimum	-0.57
Maximum	0.72	Maximum	0.51
No. of Observations	54	No. of Observations	131
Confidence Level (95.0 percent)	0.062	Confidence Level (95.0 percent)	0.028

Issued Series after the Reform		*Non- Issued Series after the Reform*	
Mean	0.025	Mean	0.009
Standard Error	0.026	Standard Error	0.009
Median	0.017	Median	0.003
Standard Deviation	0.21	Standard Deviation	0.15
Sample Variance	0.05	Sample Variance	0.02
Kurtosis	2.42	Kurtosis	7.0
Skewness	-0.43	Skewness	1.39
Minimum	-0.59	Minimum	-0.51
Maximum	0.71	Maximum	0.81
No. of Observations	68*	No. of Observations	260
Confidence Level (95.0 percent)	0.052	Confidence Level (95.0 percent)	0.018

* One observation is missing since there were no quotes in the secondary market before and during the second auction

Table 4
Elasticity

This table provides descriptive statistics on the 8 measures of elasticity of demand which were studied: 5 percent, 10 percent, 25 percent and 50 percent increase and decline in quantities. These statistics are shown separately, by type of auction and by period**.** 1/Elasticity is calculated as follows (for 5 percent, for example): (The change in price required to increase/reduce quantity by 5 percent/the Winning price of auction)/5 percent. The table reports the mean, the standard deviation and the number of auctions in which this was not possible to calculate—i.e. N is missing. The values are multiplied by 100.

Mean (Stdev) [N missing]	**Secondary Offerings**								**Initial Offerings**			
	All Offerings				**Open to PD Only**				**All offerings**			
	5 percent	**10 percent**	**25 percent**	**50 percent**	**5 percent**	**10 percent**	**25 percent**	**50 percent**	**5 percent**	**10 percent**	**25 percent**	**50 percent**
Before the Reform												
Number of observations	54								3			
Higher Quantity	0.016 (0.03) [0]	0.020 (0.04) [0]	0.027 (0.04) [0]	0.035 (0.04) [1]	-	-	-	-	0.000 (0.00) [0]	0.030 (0.05) [0]	0.053 (0.05) [0]	0.044 (0.04) [0]
Lower Quantity	0.000 (0.00) [0]	0.000 (0.00) [0]	0.011 (0.04) [0]	0.079 (0.10) [0]	-	-	-	-	0.000 (0.00) [0]	0.000 (0.00) [0]	0.000 (0.00) [0]	0.066 (0.11) [0]
After the Reform												
Number of observations	69				43				3			
Increase in Quantity	0.009 (0.02) [0]	0.016 (0.03) [0]	0.031 (0.05) [0]	0.042 (0.05) [2]	0.008 (0.02) [0]	0.014 (0.02) [0]	0.033 (0.04) [0]	0.053 (0.06) [2]	0.019 (0.03) [0]	0.021 (0.03) [0]	0.032 (0.02) [0]	0.031 (0.02) [0]
Decrease in Quantity	0.006 (0.01) [0]	0.011 (0.02) [0]	0.032 (0.04) [0]	0.101 (0.12) [0]	0.009 (0.02) [0]	0.015 (0.03) [0]	0.041 (0.04) [0]	0.116 (0.12) [0]	0.004 (0.01) [0]	0.007 (0.01) [0]	0.040 (0.03) [0]	0.099 (0.02) [0]

Table 5a

The Secondary Market's Trading Volumes of the New Issued Bonds Around the Time of the Auctions (NIS million)

	One Day Before	The Auction Day	One Day After	Two Days After	All days except the period time around the auctions	
All Auctions		1/1/2005-31/12/2007				
					The period with no auctions*	The period with auctions
Average	106.4	194.6	168.2	157.2	44.4	120.3
Median	67.7	155.1	117.6	100.0	25.8	79.0
STDEV	111.8	151.0	164.3	173.5	49.3	137.1
N	123	123	123	123	96	983
Before Reform		1/1/2005-30/3/2006				
Average	68.3	136.5	114.6	109.7	99.9	
Median	55.2	118.6	102.4	95.5	74.9	
STDEV	56.3	89.7	74.9	74.6	90.2	
N	54	54	54	54	401	
After Reform		18/6/2006-31/12/2007				
Average	136.3	240.0	210.1	194.5	134.3	
Median	88.2	208.6	147.4	116.5	84.9	
STDEV	133.8	172.8	200.0	215.5	160.3	
N	69	69	69	69	582	

* There were no auctions before the reform (between 2/4/2006 and 15/6/2006).

Table 5b

The Secondary Market's BAS (bid-ask spread) of the Issued Bonds Around the Time of the Auctions (NIS millions).

	One Day Before	The Auction Day	One Day After	Two Days After	All days except the period time around the auctions	
All Auctions		1/1/2005-31/12/2007				
					The period with no auctions*	The period with auctions
Average	0.12	0.08	0.07	0.07	0.08	0.11
Median	0.062	0.058	0.051	0.053	0.067	0.066
STDEV	0.38	0.10	0.06	0.06	0.05	0.12
N	123	121	123	123	96	981
Before Reform		1/1/2005-30/3/2006				
Average	0.06	0.06	0.06	0.06	0.06	
Median	0.053	0.061	0.050	0.052	0.057	
STDEV	0.03	0.03	0.03	0.02	0.03	
N	54	52	54	54	401	
After Reform		18/6/2006-31/12/2007				
Average	0.17	0.10	0.08	0.09	0.14	
Median	0.063	0.055	0.053	0.053	0.096	
STDEV	0.51	0.12	0.07	0.08	0.15	
N	69	69	69	69	580	

* Between 2/4/2006 and 15/6/2006.

Table 5c

The Secondary Market's Intra-day STD of the Issued Bonds Around the Time of the Auctions (NIS million)

	One Day Before	The Auction Day	One Day After	Two Days After	All days except the time around the auctions	
All Auctions		1/1/2005-31/12/2007				
					The period with no auctions*	The period with auctions
Average	0.07	0.06	0.05	0.06	0.04	0.07
Median	0.042	0.047	0.044	0.042	0.034	0.051
STD	0.09	0.05	0.04	0.05	0.04	0.08
N	123	123	123	123	96	983
Before Reform		1/1/2005-30/3/2006				
Average	0.06	0.05	0.05	0.05	0.05	
Median	0.035	0.046	0.042	0.042	0.041	
STD	0.11	0.03	0.03	0.03	0.05	
N	54	54	54	54	401	
After Reform		18/6/2006-31/12/2007				
Average	0.07	0.07	0.06	0.06	0.09	
Median	0.058	0.048	0.050	0.043	0.062	
STD	0.07	0.06	0.04	0.06	0.09	
N	69	69	69	69	582	

* Between 2/4/2006 and 15/6/2006.

Table 5d

Depth of the Secondary Market for the New Issued Bonds around the Time of the Auctions (NIS million)*

	One Day Before	The Auction Day	One Day After	Two Days After	All days except the time around the auctions	
All Auctions		1/1/2005-31/12/2007				
					The period with no auctions**	The period with auctions
Average	9.7	12.2	10.0	10.8	6.5	8.8
Median	5.8	7.4	8.0	7.9	6.4	6.1
STDEV	13.0	13.4	7.7	11.1	2.1	11.4
N	123	121	123	123	96	981
Before Reform		1/1/2005-30/3/2006				
Average	4.3	5.5	5.3	5.2	4.8	
Median	3.7	5.1	5.1	5.0	4.3	
STDEV	1.9	2.0	1.9	2.2	2.1	
N	54	52	54	54	401	
After Reform		18/6/2006-31/12/2007				
Average	13.9	17.4	13.7	15.2	11.6	
Median	9.9	11.6	11.8	11.0	8.2	
STDEV	16.1	15.9	8.5	13.1	14.1	
N	69	69	69	69	580	

* The quoted amount for the 3 best buy and sell offers of the bond series, before and after the auction. The data of the quoted amounts are time weighted over the lifetime of the order.

** Between 2/4/2006 and 15/6/2006.

Table 5e
Liquidity Measures for the Bills[a]

	Trading Volume (in NIS million)	BAS** (in percent)	Intra-day STDEV* (in percent)	Depth (in NIS million)
All Auctions			1/1/2005-31/12/2007	
Average	244	0.011	0.009	103
Median	187	0.010	0.007	73
STDEV	197	0.002	0.012	100
N	738	734	737	734
Before Reform			1/1/2005-30/3/2006	
Average	232	0.011	0.009	118
Median	190	0.010	0.007	94
STDEV	149	0.001	0.017	82
N	308	305	308	305
After Reform			18/6/2006-31/12/2007	
Average	254	0.011	0.008	99
Median	184	0.011	0.007	60
STDEV	230	0.002	0.007	112
N	392	391	391	391

* One abnormal observation was deleted on 7/10/2007. This observation was 0.6 percent, sixty eight times the average.
** Four abnormal observations were deleted because the book-order was distorted.

[a] The reform did not include *makam*, which is used as a control group.

Table 6
Descriptive Statistics—Activity of Different Trader Types
Treat each PD auction as a separate observation. Calculate the participation and awards percentages (only average—binary variable)
(NIS millions)

Auction Characteristics	Secondary Offering			
	Before Reform N= 54	After Reform All participants N=69	After Reform Auctions for Public N=26	After Reform Auctions for PD N=43
Auction participants' demand				
Large local banks (4/4/3)*	182	139	89	162
Small local banks (7/7/4)	77	63	41	103
Local brokers (11/8/4)	157	65	86	121
Large foreign banks (1/2/2)	38	90	75	95
Foreign brokers (0/6/6)		400	691	222
All participants	132	152	267	153
Awards of participants in auctions				
Large local banks	36	26	24	31
Small local banks	16	11	10	19
Local brokers	15	13	13	26
Large foreign banks	13	25	18	29
Foreign brokers		21	9	28
All participants	19	17	13	26

*(X/Y/Z) – Number of participants (Before Reform/After reform/PD only).

Table 7

Bidding Parameters: This table shows the spreads weighted by the quantity from the winning prices total and by type of trader; the allocations total and by type of trader. In addition is shows how many prices were used in bidding.

Bidding Characteristics Mean (*Median)* [STD]	Secondary Offering			Initial Offerings	
	Before Reform *N= 54*	After Reform – Auctions open to the public *N=69*	After Reform - Auctions for PD N=43	Before Reform *N= 3*	After Reform - Auctions for PD *N=3*
Number of prices used—all submissions	4.82 (4.0) [2.6]	5.69 (4.0) [4.2]	-	7.80 (6.0) [5.4]	-
Number of prices used—PD	-	5.75 (4.0) [4.3]	5.64 (4.0) [4.8]		5.66 (5.0) [3.4]
Spreads weighted by quantities—all submissions	0.19 (0.1) [0.2]	0.29 (0.1) [0.4]	-	0.349 (0.3) [0.28]	-
Spreads weighted by quantities—PD	-	0.16 (0.1) [0.3]	0.21 (0.1) [0.3]		0.48 (0.2) [0.7]

Table 7a

Bidding Parameters: Spreads weighted by quantities (NIS)

Bidding Characteristics Mean (*Median)* [STD]	Secondary Offering		
	Before Reform *N= 54*	After Reform – Auctions open to the public *N=26*	After Reform - Auctions for PD N=43
non PD	0.19 (0.1) [0.2]	0.29 (0.1) [0.4]	-
Large local banks (4/1)*	0.18 (0.1) [0.2]	0.31 (0.2) [0.4]	-
Small local banks (7/3)*	0.17 (0.1) [0.1]	0.30 (0.1) [0.5]	-
Local brokers (11/4)*	0.19 (0.1) [0.2]	0.25 (0.1) [0.4]	-
Foreign banks (1)	0.16 (0.1) [0.2]	-	-
Foreign brokers (#)	-	-	
PD	-	0.16 (0.1) [0.3]	0.21 (0.1) [0.3]
Large local banks (3)	-	0.10 (0.1) [0.1]	0.21 (0.1) [0.3]
Small local banks (4)	-	0.13 (0.1) [0.3]	0.29 (0.1) [0.5]
Local brokers (4)	-	0.22 (0.1) [0.3]	0.26 (0.2) [0.4]
Foreign banks (2)	-	0.26 (0.1) [0.6]	0.08 (0.1) [0.1]
Foreign brokers (6)	-	0.16 (0.1) [0.3]	0.13 (0.1) [0.2]

* The number of entities in each category (before the reform/after the reform).

Figure 1
Auction Premium

The premium is calculated as the median price paid at the auction minus the benchmark prices in the secondary market: SDC is equal to the closing price on the day of the auction; SDA11 is equal to the average price at the same time of the same day of the auction; PDC is equal to the closing price of the last trading day before the auction.

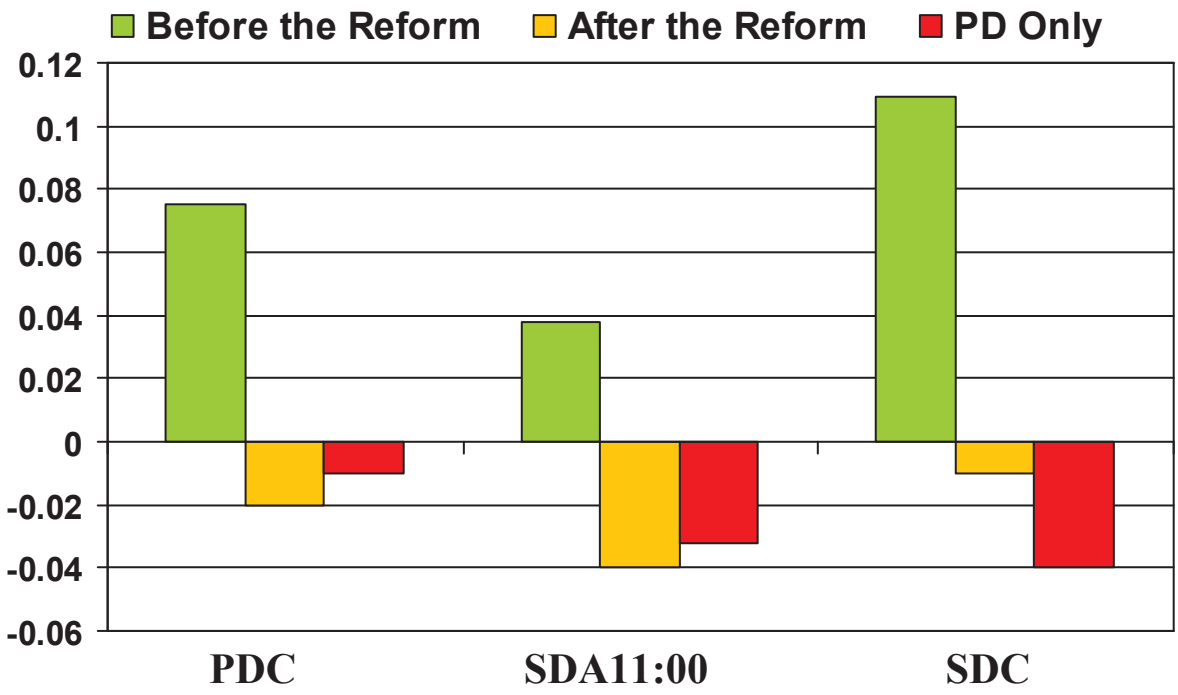
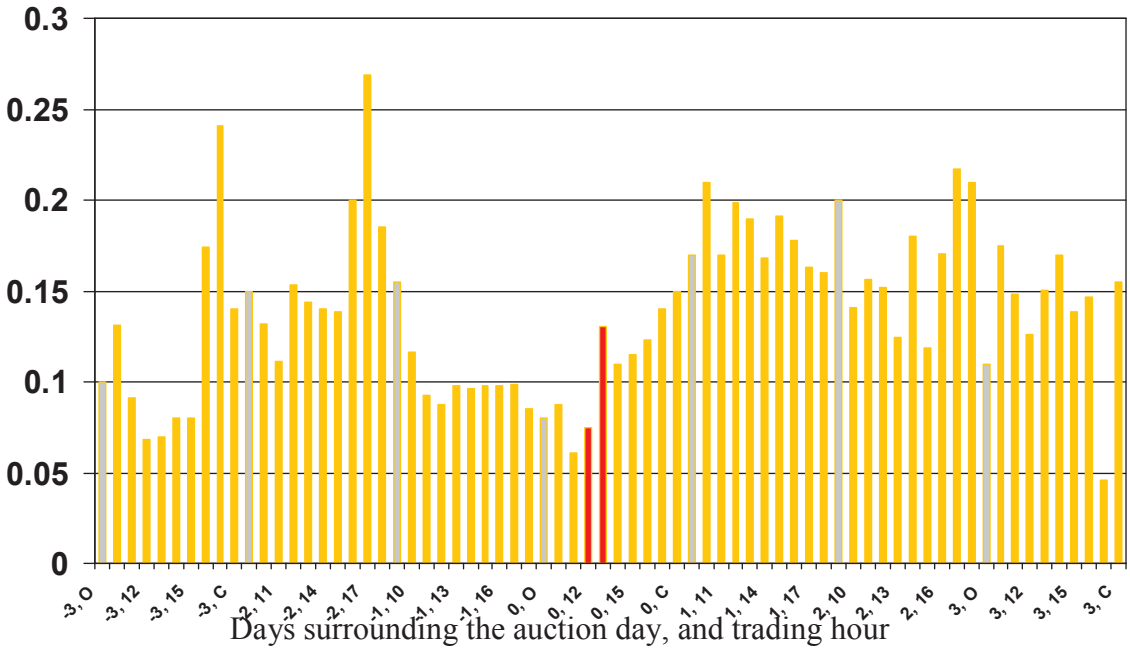


Figure 1a

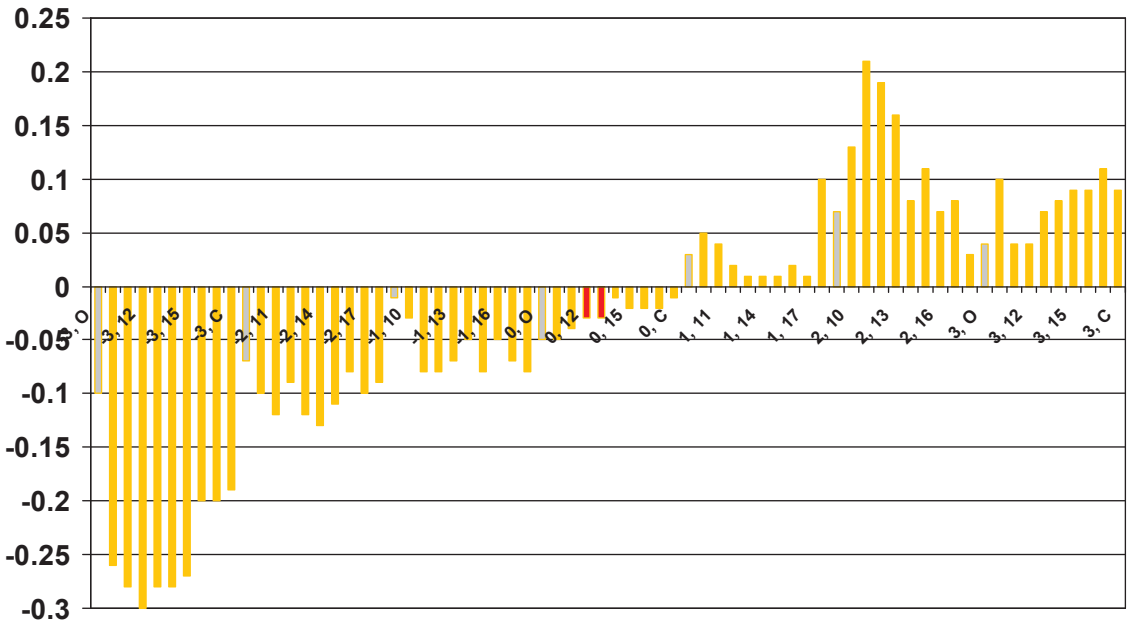
This graph shows the median spread between the price in the secondary market and the winning price in the auction, before the reform



Days surrounding the auction day, and trading hour

Figure 1b

This graph shows the median spread between the price in the secondary market and the winning price in the auction, after the reform – public auctions

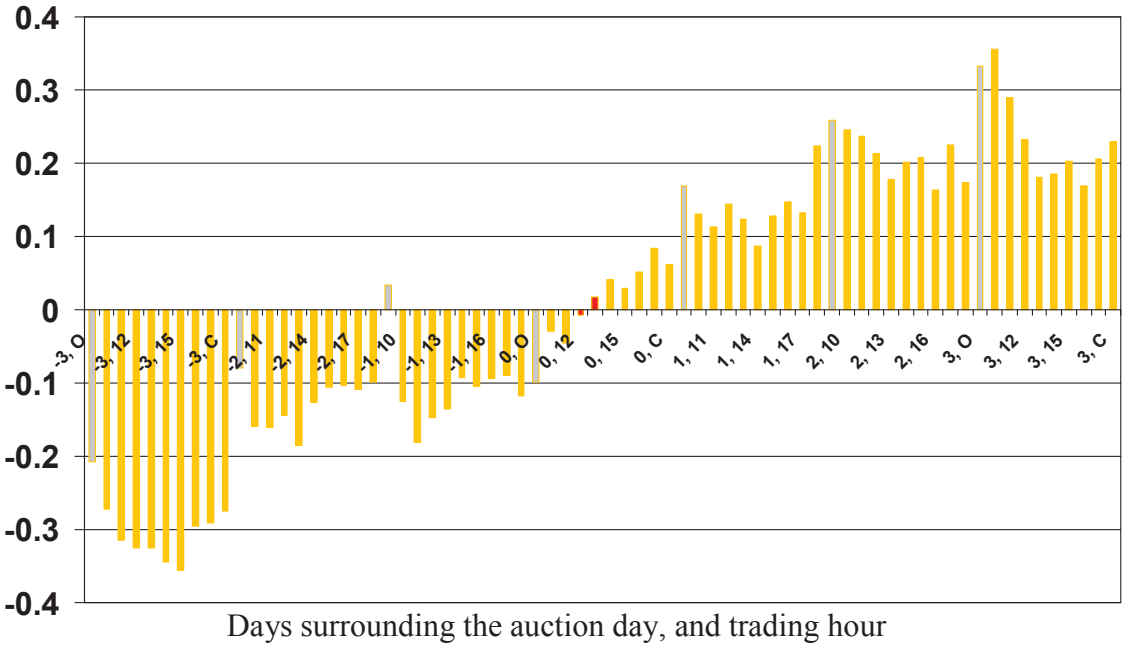


Days surrounding the auction day, and trading hour

The two red bars refer to the trading time around the auction time. The gray bars refer to the opening stage of the trading day. The time window around the auctions ranges from 3 days before the auction day until three days after the auction day (seven trading days).

Figure 1c

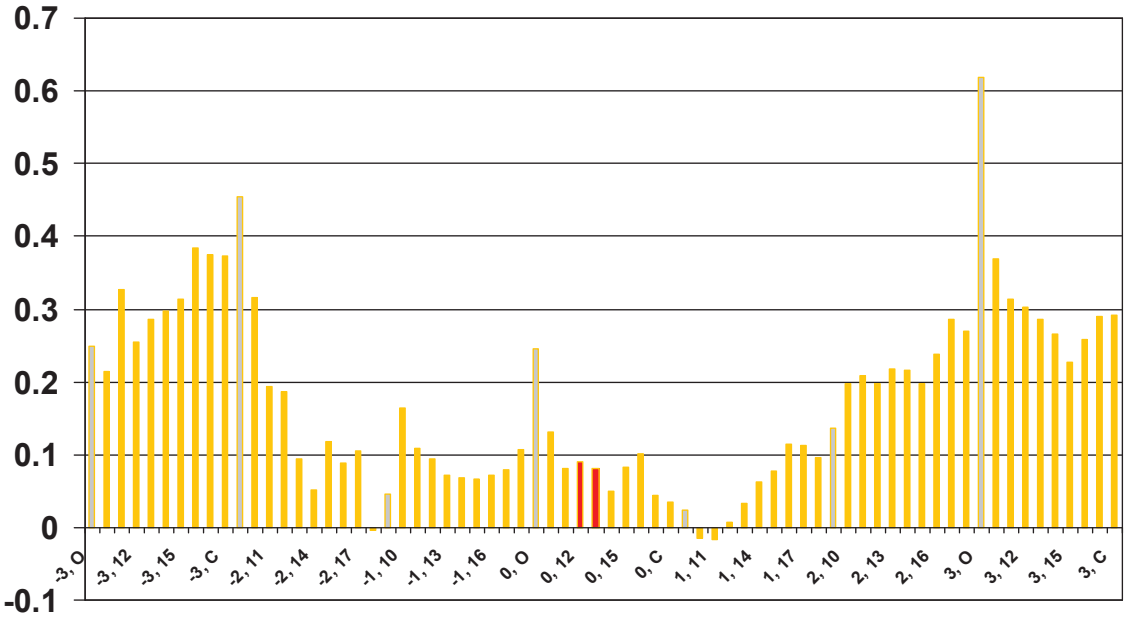
This graph shows the average spread between the price in the secondary market and the winning price in the auction, after the reform – public auctions



Days surrounding the auction day, and trading hour

Figure 1d

This graph shows the average spread between the price in the secondary market and the winning price in the auction, after the reform – Primary Dealers auctions only.



Days surrounding the auction day, and trading hour

The two red bars refer the trading close to the auction time. The gray bars refer to the opening stage of the trading day. The time window around the auctions ranges from 3 days before the auction day until three days after the auction day (seven trading days)

Figure 2
1/(Elasticity Measure) Before and After the Reform

This diagram shows the mean 1/elasticity before (green) and after (yellow) the reform. The X axis represents the change in quantity that was used for the elasticity calculation. 0.9 represents a decrease of 10 percent, 1.1 represents an increase of 10 percent. The Y axis represents the value of the 1/elasticity (Percentage changes in price relative to percentage change in quantity). The higher this value, the lower the elasticity.

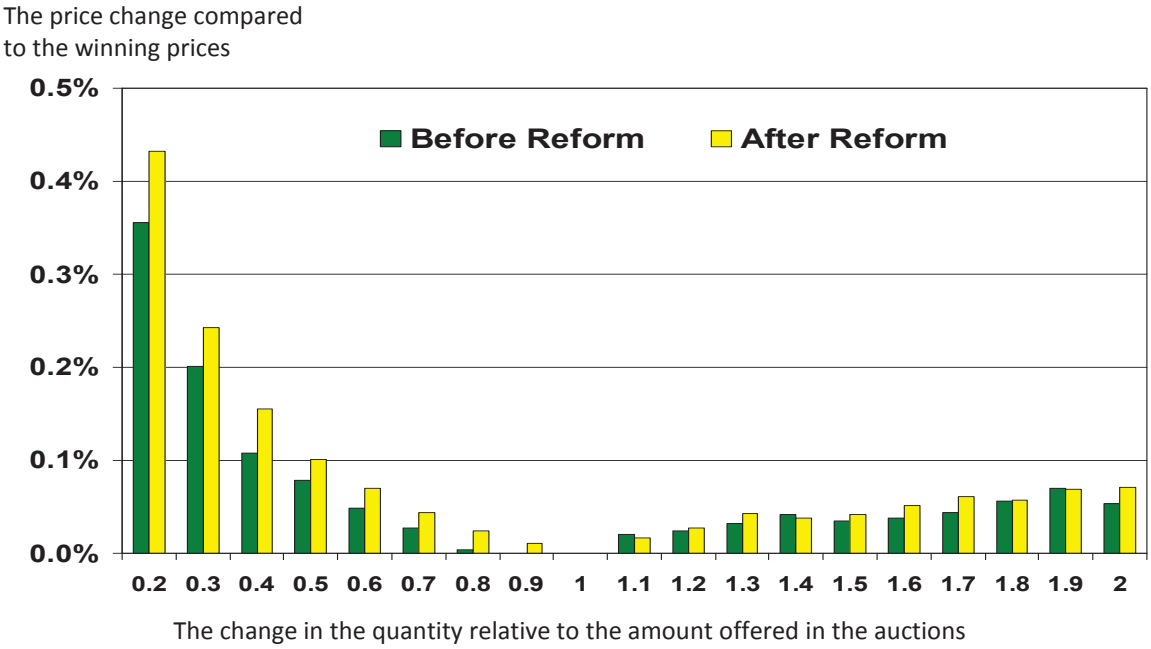
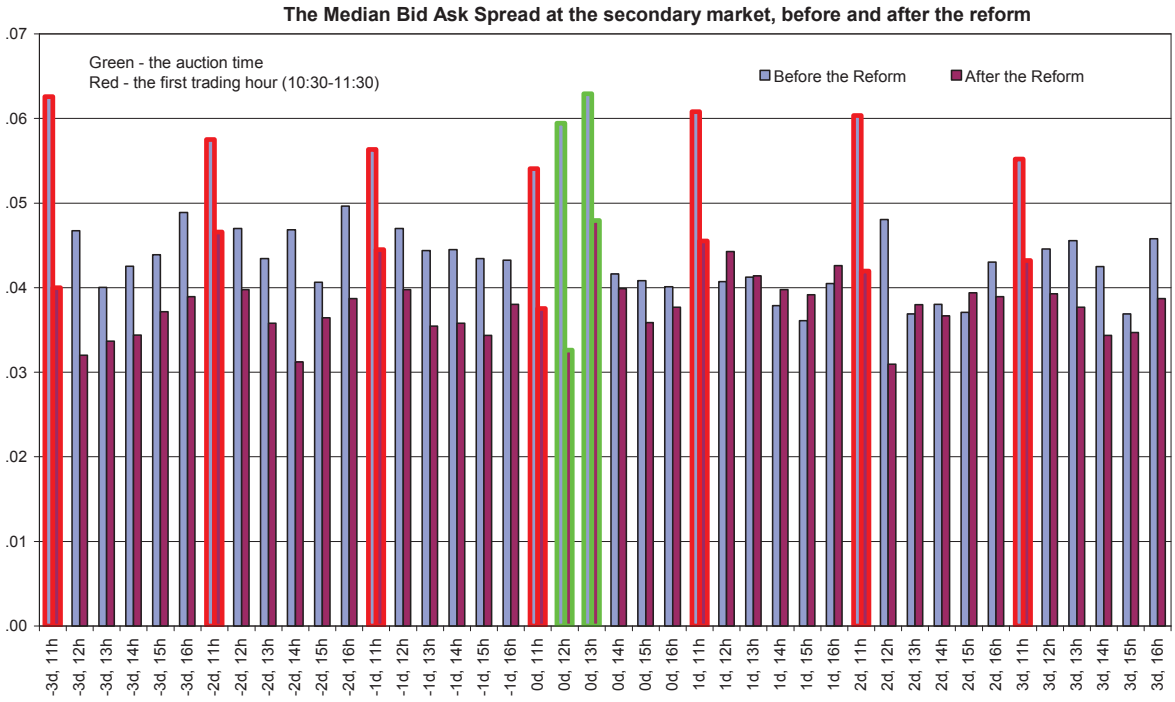
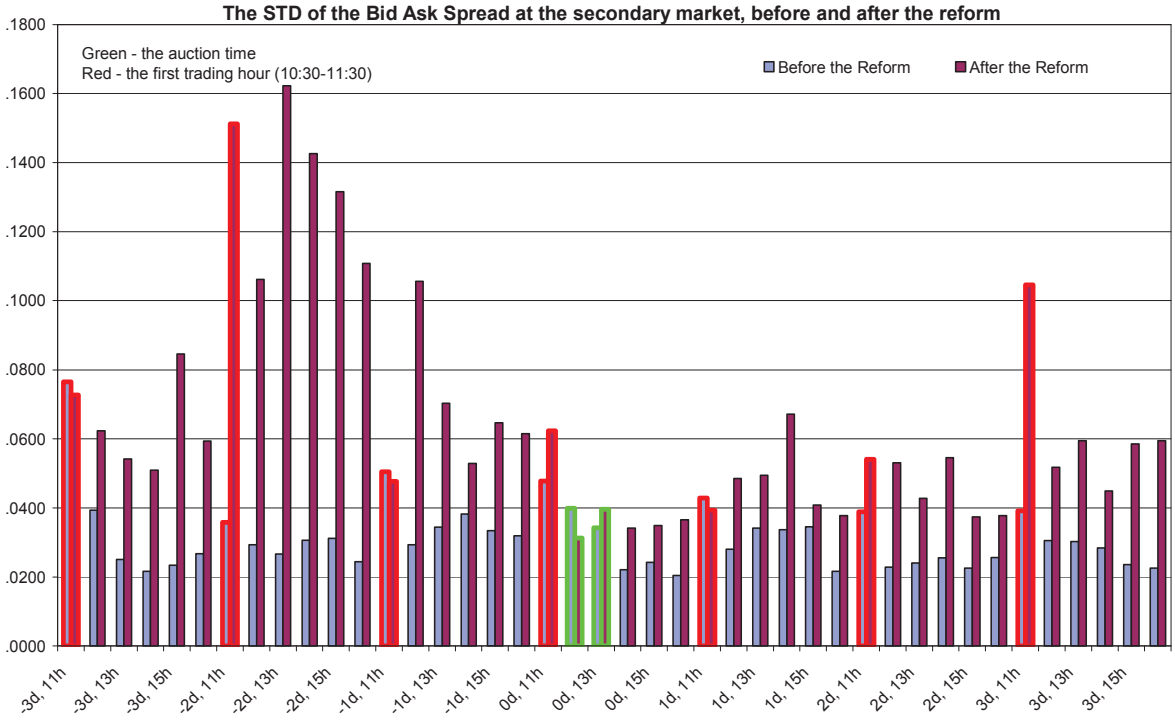


Figure 3
Bid Ask Spread (BAS)





Days surrounding the auction day, and trading hour

Figure 4a

This graph shows the amount offered in each auction and trading volume on the same day (in NIS millions)—after the reform

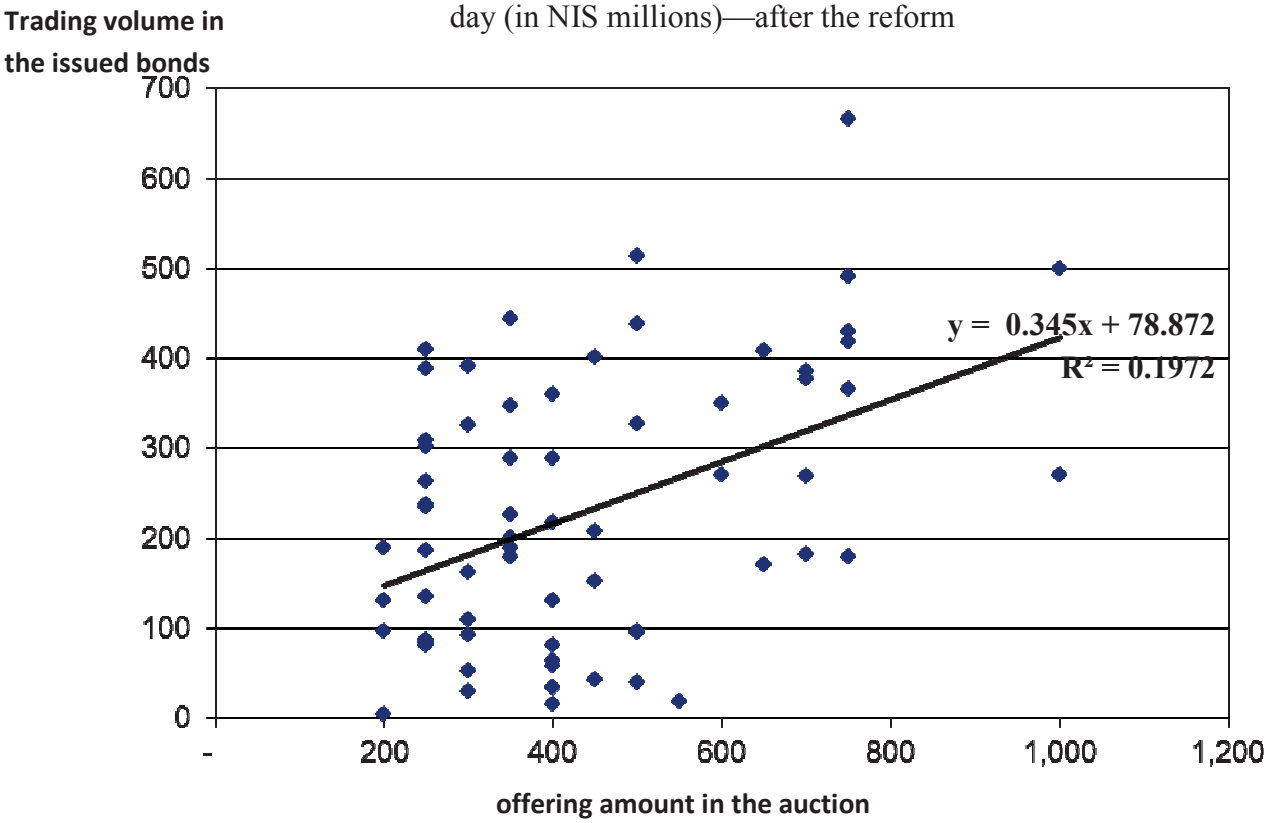


Figure 4b

This graph shows the amount offered in each auction and trading volume during the 4-day window around the auction (in NIS million)—after the reform