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**Working Paper**

## A Descriptive analysis of the Finnish treasury bond market 1991-1999

Bank of Finland Discussion Papers, No. 16/2002

**Provided in Cooperation with:**

Bank of Finland, Helsinki

*Suggested Citation:* Keloharju, Matti; Malkamäki, Markku; Nyborg, Kjell G.; Rydqvist, Kristian (2002) : A Descriptive analysis of the Finnish treasury bond market 1991-1999, Bank of Finland Discussion Papers, No. 16/2002, ISBN 951-686-793-6, Bank of Finland, Helsinki, <https://nbn-resolving.de/urn:nbn:fi:bof-20140807221>

This Version is available at:

<https://hdl.handle.net/10419/211920>

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# BANK OF FINLAND DISCUSSION PAPERS

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16 • 2002

Matti Keloharju – Markku Malkamäki –  
Kjell G. Nyborg – Kristian Rydqvist  
Research Department  
9.7.2002

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Suomen Pankin keskustelualoitteita  
Finlands Banks diskussionsunderlag

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## A descriptive analysis of the Finnish treasury bond market 1991–1999

The views expressed are those of the authors and do not necessarily reflect the views of the Bank of Finland.

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Part of this research was done while Markku Malkamäki was an employee of the Bank of Finland. The authors thank the Finnish State Treasury, the Bank of Finland, and Nordea for data, and Juhani Linnainmaa and Esa Saloranta for helpful comments.

<http://www.bof.fi>

ISBN 951-686-793-6  
ISSN 0785-3572  
(print)

ISBN 951-686-794-4  
ISSN 1456-6184  
(online)

Suomen Pankin monistuskeskus  
Helsinki 2002

# A descriptive analysis of the Finnish treasury bond market 1991–1999

Bank of Finland Discussion Papers 16/2002

Matti Keloharju – Markku Malkamäki – Kjell G. Nyborg – Kristian Rydqvist  
Research Department

## Abstract

This paper presents a descriptive analysis of the primary and secondary market for Finnish treasury bonds. The paper focuses on three issues. First, we report basic descriptive statistics such as auction volumes and secondary market yields and volumes. Second, we estimate the revenues earned by primary dealers from the treasury bond market. Third, we analyse the development of the price of the auctioned bonds, relative to other benchmark bonds, around the time of the auction. We find evidence of a price decrease in the auctioned bond series before the auction and a price increase after the auction. This pattern is strongest for 1992–1994 when Treasury funding needs were heavy and secondary market trading volume of treasury bonds was modest.

Key words: treasury bond auctions, secondary market

JEL classification numbers: D44, G12, G20

# Kuvaileva analyysi Suomen valtion sarjaobligaatioiden markkinoista 1991–1999

Suomen Pankin keskustelualoitteita 16/2002

Matti Keloharju – Markku Malkamäki – Kjell G. Nyborg – Kristian Rydqvist  
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Tutkimusosasto

## Tiivistelmä

Tutkimuksessa kuvaillaan Suomen valtion sarjaobligaatioiden ensi- ja jälkimarkkinoita. Tutkimuksessa raportoidaan kolmenlaisia asioita. Ensiksi esitetään kuvailevia tilastoja esimerkiksi huutokauppojen määristä ja volyyymeistä sekä niiden jälkimarkkinatuotoista ja -volyyymeistä. Toiseksi estimoidaan päämarkkinatakaajien sarjaobligaatioiden kaupalla ansaitsemia tuloja. Kolmanneksi analysoidaan huutokaupattavien obligaatioiden hintakehitystä muihin viitelainoihin nähden huutokauppaa ympäröivinä päivinä. Tutkimuksessa havaitaan, että huutokaupattavan lainan hinta laskee ennen huutokauppaa ja nousee sen jälkeen. Ilmiö on vahvin vuosina 1992–1994, jolloin Valtiokonttorin rahoitustarve oli hyvin suuri ja obligaatioiden jälkimarkkinavaihto melko vähäistä.

Asiasanat: sarjaobligaatioiden huutokaupat, jälkimarkkinat

JEL-luokittelu: D44, G12, G20

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# 1 Introduction

This paper presents a descriptive analysis of the primary and secondary market for Finnish Treasury bonds. Despite of its size – the amount of euro denominated Treasury bonds outstanding at the end of 2000 was EUR 42 billion – there has to date been surprisingly little empirical analysis of the Finnish Treasury bond market. A notable exception is the study of Keloharju, Nyborg, and Rydqvist (2002), which focuses on the strategic behavior of primary dealers in Treasury bond auctions. This paper attempts to fill the gap in the literature by addressing the following issues.

First, we provide some basic descriptive statistics of the primary market. In the 1990s the vast funding needs of the Finnish government made the Treasury a frequent issuer of bonds, and there are about 300 bond auctions of various types in our data. The large number of auctions allows us to measure the link between the primary market and the secondary market data with unusual precision.

Second, we report some key descriptive statistics from the secondary market. We are armed with a rich dataset which includes the volumes and yields from actual transactions between primary dealers and their customers. This allows us to accurately estimate the effective trading margins and the sales pressure associated with auctions. Effective trading margins are a key ingredient in one of the most interesting features of our work, the analysis of the secondary market trading revenues earned by the primary dealers. Complemented with an analysis of sales commissions and redemption fees generated from the primary market, trading revenues give insight into primary dealers' entry and exit from the primary dealer system.

Third, we link the primary market and secondary market together and analyze the development of the price of the auctioned bonds, relative to other benchmark bonds, around the time of the auction. We find evidence of a price decrease in the auctioned bond series before the auction and an increase in its price after the auction. We also document that the magnitude of the price change is inversely related to the magnitude of primary dealers' net sales of bonds to their customers.

A number of studies investigate Treasury auctions in other countries. Cammack (1991), Nyborg and Sundaresan (1996), and Malvey and Archibald (1998) study U.S. Treasury auctions. Umlauf (1993), Hamao and Jegadeesh (1998), and Scalia (1998) study Mexican, Japanese, and Italian auctions, respectively. Nyborg, Rydqvist, and Sundaresan (2002) examine bidder behavior in Swedish Treasury auctions. Bjønnes (2001a, 2001b) does the same for Norwegian auctions. Hansch and Saporta (1999) study the revenues of government bond market makers in the U.K.

The remainder of the paper is organized as follows. The next section describes the institutional environment that prevailed in Finland during our sample period.

Section 3 describes the data. Our empirical results are reported in Section 4. Section 5 concludes.

## 2 Institutional environment

The year 1990 marked the end of a long period of strong economic growth in Finland. At the end of 1990 the nominal value of Finnish government debt was approximately EUR 9 billion.<sup>1</sup> In 1991 the Finnish economy plunged into a severe and lengthy depression and the government accumulated EUR 5.1 billion of new, mostly foreign, debt. Figure 1 illustrates the development of Finnish government debt between January 1991 and November 1999. The debt is divided into two components, markka/euro denominated and foreign currency denominated debt. Particularly in 1992, and to a lesser extent in 1993, currency debt dominated. In 1992 currency debt increased by EUR 10.5 billion and markka debt by EUR 3.1 billion. In 1993 the corresponding numbers were EUR 8.3 billion and EUR 6.9 billion. This suggests that the State Treasury found it difficult to raise financing from domestic sources at attractive terms. In 1994 the increase in markka debt (EUR 5.2 billion) already exceeded the increase in currency debt (EUR 3.5 billion). Since 1995 the government financed its fiscal deficit by issuing domestic debt.

Saukkonen (1995) documents that in 1991–1995 U.S. dollar denominated bonds issued by the Finnish Treasury yielded on average 48 basis points more than corresponding bonds issued by the U.S. Treasury. For the German mark, the average yield differential was 28 basis points. Both yield differentials peaked between end-1992 and mid-1993, ie shortly after the surge in currency denominated borrowing.

The rapidly increasing government debt load lead to a need to establish a functioning bond market. Two important measures, worked together with the joint effort of the Treasury and the Bank of Finland, helped in reaching this goal.

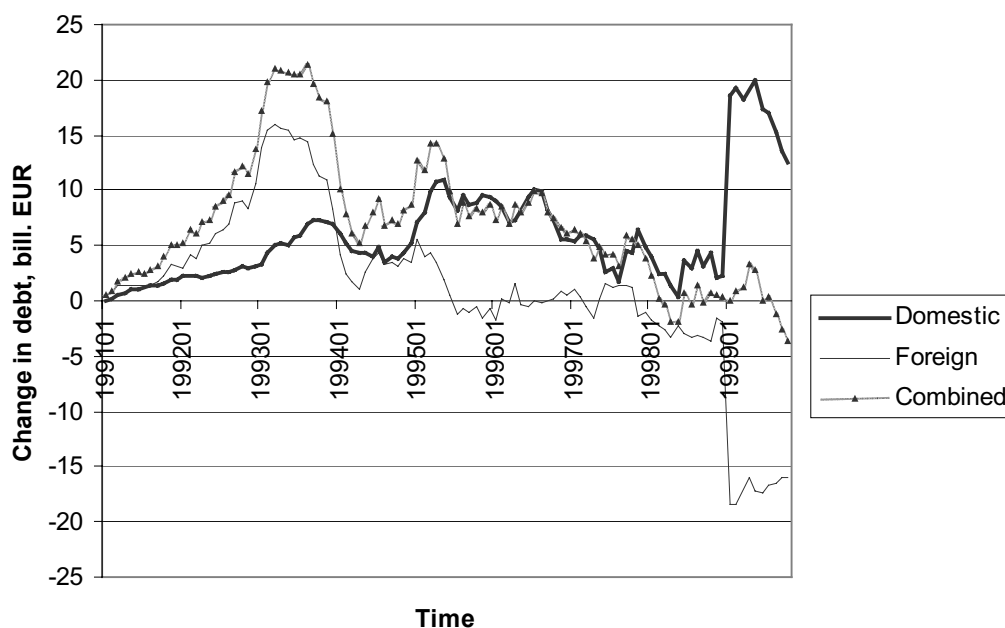
First, in 1991 the Treasury issued the first benchmark bonds. The aim of granting a bond the benchmark status is to make potential investors aware of its higher liquidity and at the same time stimulate interest in the bond market. The Treasury decides on the benchmark status after consulting with the primary dealers. Such status is granted after a bond's outstanding stock and trading volume have reached adequate levels.

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<sup>1</sup> Except for 1999, all domestic financing was initially Finnish markka denominated. We have converted markkas into euros by using the fixed 1 EUR = 5.94573 FIM exchange rate.

Figure 1.

**Change in Finnish Government's domestic and foreign debt over the previous 12 months**



Second, as of August 1992, a primary dealer system was established. The participants in this system, the primary dealers, have the privilege, but also the obligation, to bid in Treasury bond auctions. Moreover, they agree to maintain a secondary market in all market conditions by posting indicative bid and ask quotes via public information channels. The evolution of the primary dealer system and its links to the gross revenues of the dealers are sketched below. For more detailed description of the primary dealer system, see Niskanen (1996).

All five initial primary dealers were major Finnish banks. At the time of joining the system, these banks already had a long common history that had materialized eg in developing an advanced interbank payment transfer system. As will be shown later, the primary dealers earned significant revenues in the early years the system was in place. This attracted several new market participants both from Finland and from abroad. The first newcomer was the Finnish securities house Evli which was admitted to the system in May 1993. Evli was followed by the Danish Unibank, which joined the system in October 1993, and by the Finnish Branch of Svenska Handelsbanken, which became a primary dealer in August 1994. The next landmark event after the entry of Evli occurred in September 1994, when Goldman Sachs International, operating from London, joined the system. In 1994–1995 one more domestic securities house and one foreign bank became primary dealers and two original dealers, one failed bank and one merged bank, left the system. After one more foreign bank entered the system in early 1997, all ten participants remained in the system for about two years. As will be

seen later, this was also a period when the gross revenues per dealer were much lower than before. The number of primary dealers reduced to nine in January 1999 when Goldman Sachs left the system. In June-October 1999 one foreign primary dealer entered and another left the system.

### 3 Data

The data used in this study are collected from several sources. The data on benchmark bond auctions and conversions are from the Finnish Treasury and cover the period January 1, 1991 – August 31, 1999. The secondary market data, and the time series of the stock of domestic and foreign debt, are from the Bank of Finland. Since the inception of the primary dealer system in the beginning of August 1992, the Bank of Finland has required all primary dealers to supply data on all of their trades on a daily basis. This allows the Bank of Finland to compile a time series of the following variables for each bond and for each day: 1) inter-dealer volume; 2) volume of purchases from customers; 3) volume of sales to customers; 4) average inter-dealer yield; 5) average yield for purchases from customers; 6) average yield for sales to customers; and 7) average bid rate at 1 P.M. These data have been posted daily on a Reuters screen.

The average yields for the actual transactions are calculated in the following way. First, the Bank of Finland computes the equally weighted average of each primary dealer's transaction yields. Second, it computes the equally weighted average of the primary dealers' average yields. This procedure is repeated for each combination of bond series and trade category (ie inter-dealer, customer purchase, and customer sale). The average bid rate is the equally weighted average of the primary dealers' bid yields. Naturally, these are computed separately for each bond series.

The secondary market data set ends at the same time as the auction data, August 31, 1999. The auction and secondary market data are cross-checked with the data obtained from the largest primary dealer, Nordea.

### 4 Empirical results

The Finnish Treasury uses four mechanisms to sell Treasury bonds. The time series distribution and descriptive statistics relating to their relative size can be seen in Table 1. The number of regular auctions is displayed in the second column. The total number of auctions is 232, which are approximately evenly distributed over time. The average bid/auction ratio of the regular auctions is

1.765 which is considerably lower than in the U.S. (Sundaresan (1994)). The next column to the right shows the number of occasions when the Treasury has sold additional securities the next day. The total is 48. In those cases, primary dealers that are awarded in the auction get the right to purchase additional securities of up to 30% of the auction awards at a price that is equal to or higher than the auction price. Bids for additional securities must be submitted by 4 P.M. the next day. The next column shows the number of occasions when the Treasury retained securities for lending purposes. The primary dealers can borrow these securities if they have problems with meeting the physical delivery. Finally, the rightmost column shows the number of conversion auctions. When old bonds mature, the Treasury offers to redeem the old bonds for cash or to exchange the old bonds for new securities. The exchange is carried out through auction.

Table 1. **Distributions of Finnish Treasury bond auction 1991–1999**

Table 1 reports the number of regular auctions, when additional securities are sold through a non-competitive procedure the next day, when securities are retained for lending purposes, and when maturing bonds are converted to new bonds. Bid volume is the face value of bids tendered, and auction volume is the face value of the realized auction size. Both volumes are expressed in millions of euros. The volume numbers for the conversion auctions are based on six of the fifteen observations with complete data. The bid and auction volume numbers exclude one regular auction that was held in November 1999.

<b>Year</b>	<b>Regular auction</b>	<b>Additional amount</b>	<b>Lending amount</b>	<b>Conversion auction</b>
<i>Number of auctions:</i>				
1991	8	0	0	0
1992	35	3	0	0
1993	35	11	0	0
1994	31	8	0	1
1995	33	11	6	2
1996	37	11	1	2
1997	26	1	1	0
1998	22	3	2	3
1999	5	0	1	7
Totals	232	48	11	15
<i>Bid volume, mill. EUR:</i>				
Mean	317	55	n.a.	587
Median	207	50	n.a.	362
<i>Auction volume, mill. EUR:</i>				
Mean	182	40	108	551
Median	149	32	84	291
<i>Bid volume / auction volume:</i>				
Mean	1.765	2.556	n.a.	1.106
Median	1.473	1.000	n.a.	1.049

In Panel A of Table 2 we report the number of regular auctions by year and bond maturity year. By observing the columns we can see that auctions for any given maturity tend to be spread over several years. For instance, the Treasury issued bonds maturing in 1999 every year between 1992 and 1996 in a total of 41 auctions. In a typical year, the Treasury issues bonds representing five different maturities. Panel B shows the distribution of regular bond auctions by month. The bond auctions are relatively evenly distributed across the year except that the summer (August and particularly July) and the end of the year (November and particularly December) are somewhat underrepresented.

Table 2. **Number of regular Treasury bond auctions by maturity year and by month**

Panel A: Number of regular auctions by year and bond maturity year

Year	Bond maturity year											Total		
	1995	1996	1997	1999	2000	2001	2002	2003	2004	2006	2008		2009	2010
1991	8													8
1992	3		6	13			13							35
1993		2	7	9			10		7					35
1994		10	1	9			5		6					31
1995		3	2	6		10			11				1	33
1996				4		8			9	9			7	37
1997						7			6	6	3		4	26
1998					8	1			1	3	2	6	1	22
1999								3				2		5
Totals	11	15	16	41	8	26	28	3	40	18	5	8	13	232

Panel B: Number of regular auctions by month

Month	Number of auctions
1	20
2	20
3	18
4	21
5	20
6	21
7	14
8	17
9	22
10	27
11	18
12	14
Totals	232

In Table 3, we compare the quoted spread with the realized spread, which we measure as the average daily transaction yield for customers minus that for sales to customers. We can see in the middle left section that the average realized spread equals 1.14 basis points (bps) compared to the average quoted spread 3.83 bps. Below, we can see that the realized spread increases with the quoted spread but the magnitude is substantially smaller.

Table 3.

**Yield spreads and markups**

Table 3 shows the equally weighted average and median bid and ask quotes at 1 P.M., and the average transaction yield for purchases from customers (buy) and sales to customers (sell). The spreads and markups are computed from all Finnish government benchmark bonds from the period August 1, 1992 – August 31, 1999. The division of the sample to four quoted spreads is based on the quoted spreads of Nordea, the largest primary dealer.

	<b>Quoted spread (bid-ask)</b>	<b>Effective spread (buy-sell)</b>	<b>Location of bid (bid-buy)</b>	<b>Location of ask (buy-ask)</b>	<b>Markup (bid-sell)</b>
<i>Unconditional mean and median spread:</i>					
Mean	0.0383	0.0114	0.0108	0.0279	0.0231
Median	0.0300	0.0100	0.0100	0.0300	0.0200
<i>Mean spread by size of quoted spread:</i>					
2 basis points	0.0200	0.0059	0.0097	0.0102	0.0165
3 basis points	0.0300	0.0090	0.0083	0.0216	0.0184
5 basis points	0.0500	0.0177	0.0134	0.0366	0.0317
10 basis points	0.1000	0.0198	0.0183	0.0817	0.0387

The location of transaction yields relative to the quotes can be seen in the right middle section of Table 3. On average, the bid quote exceeds the purchase yield by 1.08 bps, while the ask quote is located 2.79 bps below the purchase yield. The asymmetry between these numbers suggests that transaction yields are biased against the bid quote. This suggests that market participants depart from posted bid quote and trade below. Accordingly, and consistent with Keloharju et al (2002), we define the difference between the bid quote and the yield for sales to customers as the dealer's markup. The sales yield is chosen because, as we will demonstrate later, dealers purchase in the auction to sell to customers in the secondary market. The average markup can be seen to the right in Table 3 and equals 2.31 bps. In order to construct secondary market prices for the purpose of estimating underpricing, we take the auction time bid quote and subtract the average markup from the right column. Since the markup varies systematically with the quoted spread, we vary the markup accordingly.

Table 4 reports the difference between the net proceeds from the Treasury bond auctions and their value in the aftermarket at the time of the auction, ie "the amount left on the table", by year and bond maturity. The amount left on the table consists of three components: a sales commission (0.03% of the nominal auction size<sup>2</sup>) and a redemption fee, both of which are paid directly to the primary dealers, and underpricing, ie the difference between the aftermarket price and stop-out price.

<sup>2</sup> The magnitude of sales commission represents the sales commission as of 2002. We do not have reliable evidence of whether or how the sales commission has changed over time, so we assume a constant sales commission of 0.03% throughout the sample period.



Table 4. **Amount left on the table in regular Treasury bond auctions by year and bond maturity**

Table 4 reports the difference between the net proceeds from the Treasury bond auctions and their value in the aftermarket at the time of the auction, ie “the amount left on the table”, by year and bond maturity. The amount left on the table is split into two parts: the sum of a sales commission (0.03% of nominal auction size) and redemption fee, paid directly to the primary dealers, and underpricing, ie the difference between the aftermarket price and stop-out price. When there is no information on redemption fees, we use the average redemption fee of 0.283%. There is no redemption fee since April 1996. The yield used for computing the aftermarket price is the average bid of all primary dealers minus the markup, ie the time-varying average effective spread between the average bid rate and the average rate for actual sales to customers (bid-sell, from Table 3). When there is no aftermarket price (ie no bid rate) on the auction day, we compute the aftermarket price by adding the average underpricing of 0.041% to the stop-out price. The sample includes all 232 regular Treasury bond auctions from 1991–1999 except for one auction in November 1999. Primary dealer revenues from additional auctions and conversions, for which we have incomplete data, are not considered.

Panel A: Distribution of the money left on the table by bond maturity

<b>Maturity</b>	<b>Underpricing, mill EUR</b>	<b>Redemption fee and sales commission, mill. EUR</b>	<b>Totals, mill. EUR</b>
1995	0.53	1.76	2.29
1996	0.21	12.13	12.34
1997	-0.78	7.04	6.25
1999	0.61	15.11	15.72
2000	0.80	0.83	1.64
2001	-0.45	9.20	8.75
2002	0.41	4.85	5.26
2003	0.17	0.23	0.40
2004	4.83	17.13	21.96
2006	4.58	1.63	6.21
2008	1.81	0.59	2.41
2009	3.10	0.79	3.89
2010	0.60	1.35	1.96
<b>Totals</b>	<b>16.43</b>	<b>72.65</b>	<b>89.08</b>

Panel B: Distribution of the money left on the table by auction year

<b>Year</b>	<b>Underpricing, mill. EUR</b>	<b>Redemption fee and sales commission, mill. EUR</b>	<b>Totals, mill. EUR</b>	<b>Average # of primary dealers</b>	<b>Total money left on the table per dealer, mill. EUR</b>
1991	0.36	1.32	1.68	n.a.	n.a.
1992	-0.29	5.38	5.09	5.00	1.02
1993	1.30	15.58	16.88	5.92	2.85
1994	2.91	14.13	17.04	7.96	2.14
1995	1.25	25.09	26.34	9.54	2.76
1996	3.79	6.13	9.92	9.00	1.10
1997	3.10	2.55	5.65	9.96	0.57
1998	4.33	2.12	6.45	10.00	0.65
1999	-0.33	0.35	0.02	9.13	0.00
<b>Totals</b>	<b>16.43</b>	<b>72.65</b>	<b>89.08</b>		

We can see from the last row from Panel A that about 82% of the money left on the table, EUR 73 million, is due to redemption fees and sales commissions. The redemption fee, a fee for manually handling physical bond certificates, is on average 0.283% of gross proceeds from the auction and varies between 0.163% and 0.365%. It was abolished in April 1996.<sup>3</sup> This explains why the redemption fee, and the total amount of money left on the table, is largest in the earlier sample years – when the Treasury’s bargaining position with respect to the primary dealers was probably the weakest. We do not have data for the redemption fees for additional auctions or conversions. However, assuming that the primary dealers charged the same percentage redemption fee from additional auctions as from ordinary auctions held at the same time, the combined additional auction redemption fee is EUR 4.87 million from the entire sample period. Given that most conversions occurred towards the end of the sample period when redemption fees no longer existed, the redemption fee revenue from conversions is probably much smaller.

Underpricing, on average 0.041% of gross proceeds, accounts for the remaining 20%, or EUR 16.4 million, of the money left on the table. Except for two bond series, all bond series were on average underpriced. The results concerning underpricing are robust to the method for estimating the secondary market price. For instance, using a fixed markup during the entire sample period instead of a time-varying markup would change the total amount of underpricing by less than 10%, from EUR 16.43 million to EUR 17.82 million.

Trading revenues of primary dealers derive from three sources: the bid-ask spread, the appreciation of inventory accumulated through trading, and the coupon receipts of bonds in that inventory. Given the absence of inventory data,<sup>4</sup> we shall focus on the bid-ask spread, ie the trading margin.

Table 5 investigates the distribution of trading volume and trading margin by year and bond maturity. The trading margin is the product of customer trading volume and effective half-spread, and it is computed separately for each day and bond series. Customer trading volume is the sum of primary dealers’ buy and sell volume with their customers, and the effective half spread is one half of the difference between average price for sales to customers and purchases from customers.

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<sup>3</sup> The information on redemption fees (“lunastuspalkkio”) is collected from the Treasury’s original bond auction sheets. As of April 1996, the auction sheets no longer include remarks of redemption fees.

<sup>4</sup> The availability of data on auction volumes and customer trading volume makes it in principle possible to estimate the aggregate size of primary dealer inventory. However, given that not all auctioned bonds are sold to the customers in the secondary market, and that there appears to be substantial variation in the ratio of net customer sales to auction proceeds, it is very difficult to estimate aggregate inventories in a reliable way.

Table 5.

### Trading volume and trading margin by bond maturity and year

Table 5 shows the customer trading volume and trading margin for all Finnish government benchmark bonds for the period August 1, 1992 – August 31, 1999. The trading margin is the product of customer trading volume and effective half-spread, and it is computed separately for each day and bond series. Customer trading volume is the sum of primary dealers' buy and sell volume with their customers, and the effective half spread is one half of the difference between average price for sales to customers and purchases from customers. Panel A reports daily average and median trading margins and volumes, pooled over all trading days with a given bond maturity, by maturity. Panel B reports average and median trading margins and volumes by auction year.

Panel A: Volume and trading margin by bond maturity

Maturity	Volume, mill. EUR			Trading margin, mill. EUR			N	# of pos. tr. margin days / # of all non-zero tr. margin days	Trading margin / volume
	Daily Mean	Daily Median	Sum over all obs.	Daily Mean	Daily Median	Sum over all obs.			
1995	11	7	5,032	0.0026	0.0005	1.21	466	81.82%	0.024%
1996	60	46	19,500	0.0057	0.0036	1.87	326	88.81%	0.010%
1997	34	22	31,174	0.0054	0.0027	4.91	915	84.22%	0.016%
1999	67	44	93,111	0.0088	0.0056	12.18	1390	81.34%	0.013%
2000	50	22	12,621	0.0026	0.0001	0.66	252	82.74%	0.005%
2001	65	49	65,223	0.0079	0.0013	7.91	999	76.66%	0.012%
2002	12	4	20,118	0.0063	0.0003	10.15	1619	87.19%	0.050%
2003	32	17	4,414	0.0049	0.0011	0.69	140	83.84%	0.016%
2004	70	51	109,652	0.0184	0.0089	28.90	1569	79.59%	0.026%
2006	72	52	55,661	0.0152	0.0028	11.71	773	76.30%	0.021%
2008	50	34	22,598	0.0102	0.0012	4.59	449	76.62%	0.020%
2009	68	52	18,186	0.0086	0.0000	2.31	269	63.49%	0.013%
2010	27	12	7,462	0.0034	0.0000	0.93	279	73.60%	0.013%
Totals	49	29	464,752	0.0093	0.0020	88.03	9446	80.82%	0.019%

Panel B: Volume and trading margin by year

Year	Volume, mill. EUR			Trading margin, mill. EUR			N	# of pos. tr. margin days / # of all non-zero tr. margin days	Trading margin / volume
	Daily Mean	Daily Median	Sum over all obs.	Daily Mean	Daily Median	Sum over all obs.			
1992	13	8	4,294	0.0051	0.0004	1.74	341	77.43%	0.041%
1993	31	21	35,847	0.0118	0.0043	13.57	1150	86.75%	0.038%
1994	44	28	55,091	0.0124	0.0050	15.73	1265	83.27%	0.029%
1995	54	38	68,276	0.0102	0.0041	12.75	1255	86.82%	0.019%
1996	63	47	78,190	0.0146	0.0039	18.18	1244	85.13%	0.023%
1997	73	45	93,521	0.0087	0.0000	11.20	1280	75.72%	0.012%
1998	52	32	83,984	0.0049	0.0000	7.91	1624	72.32%	0.009%
1999	35	20	45,550	0.0054	0.0003	6.95	1287	75.45%	0.015%
Totals	49	29	464,752	0.0093	0.0020	88.03	9446	80.82%	0.019%

From the last row of Panel A in Table 5 we can see that the daily mean customer volume is EUR 49 million per bond and the median EUR 29 million. The combined customer trading volume of all bonds between August 1, 1992 and August 31, 1999 was EUR 465 billion, two times as much as the combined inter-dealer trading volume (EUR 228 billion). The trading volume increased monotonically from 1992 to 1997 and then decreased during the last two sample years. The average trading margin, reported in the bottom row in the rightmost column, is 0.019%. The highest margin, 0.050%, is recorded for the 2002 series, which has the lowest median trading volume in the sample.<sup>5</sup> The combined trading margin over the sample period is EUR 88 million, ie about 15% higher than the combined money left on the table in the primary market between 1991–1999. Based on the evidence in Hansch and Saporta (1999), the total trading revenues may be substantially higher. They show that market makers in the gilt market incur positive positioning revenues accounting roughly 40% of their total trading revenues.<sup>6</sup> If positioning revenues of this magnitude were to apply in the Finnish Treasury bond market, this would translate to a combined positioning revenue of about EUR 60 million throughout the sample period.

Table 6 computes the sum of redemption fees and sales commissions (reported in Table 4) and trading margins (reported in Table 5) on an annual and per dealer basis. This results in an estimate of the gross revenues of the primary dealers, reported in the third column from right. As we can observe by looking at this column, and the rightmost column that reports gross revenues per primary dealer, the largest gross revenues occurred in 1993–1996. In 1997–1999 the gross revenues were notably smaller due to the shrinkage in trading margins and the end to the redemption fees.

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<sup>5</sup> Technically this bond differs from the other bonds in that it is backed by a pool of mortgages rather than by the Finnish Government.

<sup>6</sup> Market makers earn trading revenues from the bid-ask spread, whereas positioning revenues incur from positions when asset prices change.

Table 6.

**Sales commission, redemption fee, and trading margin by year and per dealer**

Table 6 shows the distribution of trading margins, sales commissions, and redemption fees by year. The data on redemption fees and sales commissions comes from Table 4 and the data on trading margins from Table 5. The trading margins are computed from all Finnish government benchmark bonds from the period August 1, 1992 – August 31, 1999. The trading margins in 1992 and 1999 are computed on an annual basis.

<b>Year</b>	<b>Trading margin, mill. EUR</b>	<b>Redemption fee and sales commission, mill. EUR</b>	<b>Totals, mill. EUR</b>	<b>Average # of primary dealers</b>	<b>Totals per primary dealer, mill. EUR</b>
1992	4.18	5.38	9.55	5.00	1.91
1993	13.57	15.58	29.15	5.92	4.93
1994	15.73	14.13	29.86	7.96	3.75
1995	12.75	25.09	37.84	9.54	3.97
1996	18.18	6.13	24.31	9.00	2.70
1997	11.20	2.55	13.75	9.96	1.38
1998	7.91	2.12	10.03	10.00	1.00
1999	10.43	0.35	10.78	9.13	1.18

Table 7 shows the development of trading volume during a nine-day window around the auctions. Panel A reports the ratio of inter-dealer trading volume on each of the nine days to the sum of inter-dealer volume on all nine days. We compute these ratios both for the auctioned bonds and for benchmark bonds that are not auctioned. When more than one bond is auctioned on a given day, or there are several benchmark bonds, the equally weighted average of the bonds is used as the unit of observation.

The top row in Panel A, Table 7 suggests that the inter-dealer trading volume is highest on the auction day for the auctioned bonds. However, as shown in the second row from top, there is also a similar increase in the volume of benchmark bonds. Overall, the volume for the auctioned bond tends to be below that of the benchmark bond, and a non-parametric test finds a significant difference between the auctioned and benchmark bond volumes on four of the nine days in the event window.

Panel B of Table 7 reports trading volume of primary dealers' purchases from their customers. Like for inter-dealer volume, there is a notable peak in purchase volume for the auctioned bonds on the auction day. For example, the fraction of purchase volume ranges from 9.35% to 11.00% on the four days immediately preceding the auction, but jumps to 18.20% on the auction day. There is also an increase in the trading volume of benchmark bonds, but this increase is much less remarkable. On the auction day the volume difference between the auctioned bonds and benchmark bonds is 4.14% of the aggregate volume during the nine-day window, a highly significant result. This suggests that there is a significant abnormal increase in purchases from customers on the auction day, perhaps an

outcome of the risk arbitrage opportunity created by the difference between the secondary market price and the expected auction price.

Table 7. **Trading volume around the auction day**

Table 7 shows the development of trading volume during a nine-day window around regular auctions for all Finnish government benchmark bonds for the period August 1, 1992 – August 31, 1999. Panel A reports trading volume among primary dealers and Panels B and C trading volume of primary dealers' purchase and sales transactions with their customers, respectively. The row "Auction average" refers to the trading volume for the auctioned bonds and the row "Benchmark average" for the trading volume for the remaining bonds at the same time. When more than one bond is auctioned on a given day, or there are several benchmark bonds, the equally weighted average of the bonds is used as the unit of observation.

Panel A: Primary dealer trades

	Volume on day t / Volume on days t-4 thru t+4								
	Day t = Auction days plus								
	-4	-3	-2	-1	0	1	2	3	4
Auction average	12.16%	10.82%	11.28%	12.33%	15.08%	12.09%	10.76%	13.04%	14.38%
Benchmark average	14.04%	12.24%	13.29%	12.65%	15.09%	13.74%	11.59%	13.00%	15.10%
Average difference	-1.88%	-1.42%	-2.01%	-0.31%	-0.01%	-1.65%	-0.82%	0.04%	-0.72%
t-value	-1.96	-1.83	-2.50	-0.41	-0.01	-1.94	-1.18	0.05	-0.85
Fraction positive	40.68%	43.59%	33.07%	42.86%	45.16%	37.69%	39.50%	45.60%	43.75%
z-value	-2.03	-1.39	-3.82	-1.60	-1.08	-2.81	-2.29	-0.98	-1.41
N	118	117	127	126	124	130	119	125	128

Panel B: Purchases from customers

	Volume on day t / Volume on days t-4 thru t+4								
	Day t = Auction days plus								
	-4	-3	-2	-1	0	1	2	3	4
Auction average	10.10%	9.35%	10.39%	11.00%	18.20%	11.54%	10.55%	11.62%	12.47%
Benchmark average	12.03%	10.74%	13.12%	12.54%	14.05%	13.21%	11.24%	13.19%	14.39%
Average difference	-1.93%	-1.39%	-2.73%	-1.55%	4.14%	-1.68%	-0.69%	-1.58%	-1.91%
t-value	-2.56	-1.87	-3.84	-1.85	3.74	-2.25	-0.89	-2.18	-2.34
Fraction positive	43.18%	42.86%	35.16%	40.74%	63.50%	39.69%	45.04%	43.61%	40.58%
z-value	-1.57	-1.60	-3.36	-2.15	3.16	-2.36	-1.14	-1.47	-2.21
N	132	126	128	135	137	131	131	133	138

Panel C: Sales to customers

	Volume on day t / Volume on days t-4 thru t+4								
	Day t = Auction days plus								
	-4	-3	-2	-1	0	1	2	3	4
Auction average	7.70%	6.47%	7.64%	8.11%	37.66%	8.66%	7.17%	8.78%	9.23%
Benchmark average	12.94%	10.81%	12.14%	12.06%	13.23%	12.04%	11.27%	12.52%	14.39%
Average difference	-5.24%	-4.34%	-4.50%	-3.95%	24.43%	-3.37%	-4.10%	-3.74%	-5.16%
t-value	-6.31	-8.01	-6.67	-5.68	19.63	-4.77	-6.76	-5.45	-7.16
Fraction positive	18.66%	20.90%	26.47%	26.62%	95.71%	34.78%	31.11%	26.47%	25.55%
z-value	-7.26	-6.74	-5.49	-5.51	10.82	-3.58	-4.39	-5.49	-5.72
N	134	134	136	139	140	138	135	136	137

Panel C of Table 7 reports trading volume of primary dealers' sell transactions with their customers. Like in Panels A and B, the peak volume for both the auctioned and benchmark bonds is achieved on the auction day. The results differ from the earlier panels mostly in the magnitude of the increase in sales volume of the auctioned bond on the auction day. The fraction of sales volume ranges from 6.47% to 8.11% on the four days immediately preceding the auction, and between 7.17% to 9.23% on the four days immediately following the auction, but is as

much as 37.66% on the auction day. The average auction day difference between the auctioned bond and the benchmark bond is 24.43%, a highly significant result.

Table 8 shows the development of net sales volume scaled by auction size during a nine-day window around the auction. Net sales volume is defined as the difference between sales volume to customers and purchase volume from customers. Consistent with Table 7, there is a peak in net sales on the auction day. This constitutes on average 52% of auction size. This is consistent with the notion that the primary dealers purchase the bonds on behalf of their customers and place them in client portfolios immediately after the auction. The top two rows of the table also show that net sales are on average positive on all event days. In other words, the primary dealers empty their portfolios before the auction and remain net sellers of the auctioned bonds also after the auction. The sum of average (median) ratios between net sales and auction size over the nine event days, tabulated in the rightmost column, is 66% (65%). Although not reported here formally, the ratio of net sales to auction size was somewhat higher in 1992–1994 than in 1995–1999. In the earlier period the sum of average net sales ratios over the nine event days was 74% whereas in the latter period it was 59%.

Table 8. **Net sales volume of Treasury bonds around the auction day**

Table 8 shows the development of net sales volume scaled by auction size during a nine-day window around regular auctions for all Finnish government benchmark bonds for the period August 1, 1992 – August 31, 1999. Net sales is the difference between sales volume to customers and purchase volume from customers. When more than one bond is auctioned on a given day, the equally weighted average of the bonds is used as the unit of observation.

	Net sales on day t / Auction size									Sum of days -4 thru 4
	Day t = Auction day plus									
	-4	-3	-2	-1	0	1	2	3	4	
Average	3.84%	0.44%	1.38%	1.00%	51.76%	4.24%	2.45%	0.45%	0.41%	65.98%
Median	0.00%	0.71%	1.40%	1.15%	55.22%	2.47%	1.70%	0.94%	1.30%	64.90%
t-value	1.49	0.39	0.82	0.74	17.87	1.86	1.70	0.30	0.26	
Fraction positive	42.66%	56.64%	59.44%	53.85%	89.51%	59.44%	54.55%	54.55%	56.64%	
z-value	-1.76	1.59	2.26	0.92	9.45	2.26	1.09	1.09	1.59	
N	143	143	143	143	143	143	143	143	143	

Table 9 shows the development of secondary market prices during an eight-day window around the auctions. A price change for an auctioned bond is computed relative to its price four days before the auction. The reported price changes are price changes for the auctioned bonds less the average price changes for the same period for the bonds not auctioned. Panel A reports the price changes for the full sample period, Panel B for subperiod 1992–1994, and Panel C for subperiod 1995–1999. All prices are actual transactions prices from transactions conducted among primary dealers. When more than one bond is auctioned on a given day, or there are several benchmark bonds, the equally weighted average of the bonds is used as the unit of observation.

Table 9. **Price changes of Treasury bonds around the auction day**

Table 9 shows the development of secondary market prices during an eight-day window around regular auctions for all Finnish government benchmark bonds for the period August 1, 1992 – August 31, 1999. A price change for an auctioned bond is computed relative to its price four days before the auction. The reported price changes are price changes for the auctioned bonds less the average price changes from the same period for the bonds not auctioned. Panel A reports the price changes for the full sample period, Panel B for subperiod 1992–1994, and Panel C for subperiod 1995–1999. All prices are actual transactions prices from transactions conducted among primary dealers. When more than one bond is auctioned on a given day, or there are several benchmark bonds, the equally weighted average of the bonds is used as the unit of observation.

Panel A: Full sample period 1992–1999

	Price change for auctioned bond – Price change for benchmark bond relative to auction day –4							
	Auction day –4			Auction day plus				
	–3	–2	–1	0	1	2	3	4
Auction	–0.04%	–0.05%	–0.07%	–0.15%	–0.19%	–0.14%	–0.07%	–0.10%
Median	–0.01%	–0.03%	–0.05%	–0.06%	–0.08%	–0.11%	–0.01%	–0.03%
t-value	–1.11	–1.66	–2.41	–3.16	–3.47	–2.38	–1.22	–1.51
Fraction positive	49.53%	43.52%	40.37%	39.45%	39.25%	37.62%	49.06%	46.36%
z-value	–0.10	–1.35	–2.01	–2.20	–2.22	–2.49	–0.19	–0.76
N	107	108	109	109	107	101	106	110

Panel B: 1992–1994

	Price change for auctioned bond – Price change for benchmark bond relative to auction day –4							
	Auction day –4			Auction day plus				
	–3	–2	–1	0	1	2	3	4
Auction	–0.04%	–0.07%	–0.12%	–0.31%	–0.42%	–0.33%	–0.26%	–0.39%
Median	–0.02%	–0.08%	–0.08%	–0.21%	–0.30%	–0.20%	–0.13%	–0.17%
t-value	–0.57	–1.21	–2.41	–3.27	–3.58	–2.92	–2.37	–3.01
Fraction positive	45.45%	32.56%	32.56%	22.73%	26.83%	28.57%	35.71%	31.11%
z-value	–0.60	–2.29	–2.29	–3.62	–2.97	–2.78	–1.85	–2.53
N	44	43	43	44	41	42	42	45

Panel C: 1995–1999

	Price change for auctioned bond – Price change for benchmark bond relative to auction day –4							
	Auction day –4			Auction day plus				
	–3	–2	–1	0	1	2	3	4
Auction	–0.03%	–0.03%	–0.04%	–0.04%	–0.05%	0.00%	0.06%	0.10%
Median	0.02%	0.00%	–0.02%	0.01%	–0.03%	–0.05%	0.03%	0.09%
t-value	–1.30	–1.13	–1.04	–0.91	–1.10	–0.07	1.21	1.87
Fraction positive	52.38%	50.77%	45.45%	50.77%	46.97%	44.07%	57.81%	56.92%
z-value	0.38	0.12	–0.74	0.12	–0.49	–0.91	1.25	1.12
N	63	65	66	65	66	59	64	65

Panel A indicates that the benchmark-adjusted prices for the auctioned bonds drift downward after event day –4. The average (median) adjusted price change is –0.15% (–0.06%) on event day 0 and –0.19% (–0.08%) on event day +1. From day 2, the benchmark-adjusted bond prices start to pick up, but the adjusted prices never reach the level they started from. The average adjusted price change relative to event day –4 is –0.10% (–0.03%) on event day +4. All price changes relative to



event day  $-4$  between event days  $-1$  and  $+2$  are significantly negative at the 5% level.

Panel B reports the development of benchmark-adjusted prices for bonds auctioned in 1992–1994. The price pattern up to the auction is similar as in Panel A but more distinct. The average (median) adjusted price change relative to event day  $-4$  is  $-0.31\%$  ( $-0.21\%$ ) on event day 0 and  $-0.42\%$  ( $-0.30\%$ ) on event day  $+1$ . Despite of a relatively small number of observations, these price changes are highly significant. However, perhaps due to the relatively small number of observations, there is no clear evidence that the price of the auctioned bond would pick up after the auction: the mean price drifts downward from day 0 to day  $+4$ , whereas the median price and the fraction of positive differences drift upward. Panel C, which reports the results for 1995–1999, finds a small price decline from day  $-4$  up to the auction day and a somewhat larger price increase during the next four trading days. These results, however, are not statistically significant at the 5% level.

What accounts for the abnormal price development for auctioned bonds around the auctions? There are three potential explanations.

First, a bond auction causes a supply shock that the market may not be willing to absorb without a discount. Scholes (1972), Kraus and Stoll (1972), Keim and Madhavan (1996) and others show that supply shocks due to block trades temporarily depress stock prices and that the price adjusts already before the actual transaction as information leaks that a block is being shopped around. Kyle (1989) and Wang and Zender (2002) point out that dealers require a risk premium to bear the price risk between the auction and the time they sell the securities to final investors (although Keloharju et al (2002) find that the models behind this risk sharing argument are not fully consistent with the pattern of bidding behavior and underpricing in Finnish Treasury bond auctions). As shown in Table 8, the supply shock lasts for several days and it also takes several days for the price to recover. Although not reported here formally, there is evidence that bond auctions with the highest cumulative net sales of bonds during the event window are associated with the highest price declines: the correlation between the cumulative benchmark-adjusted price change on the auction day and the corresponding cumulated ratio of primary dealer net sales to auction size is  $.28$  (t-value 3.03). As shown in Panel B of Table 9, evidence of price pressure is strongest in the beginning of the sample period when the secondary market trading volume was relatively modest and the effect of a supply shock was probably the strongest.

Second, there might be excess private information at the time of the auction, giving raise to an adverse selection problem. The microstructure literature (see, eg, Bagehot (1971), Copeland and Galai (1983), Glosten and Milgrom (1985), and Glosten and Harris (1988)) suggests that the presence of excessive private information tends to be associated with decreased volumes and wider spreads, thereby inducing lower prices. However, as shown in Table 7, trading volume

tends to be abnormally high on the auction day, not vice versa. Moreover, although not reported here formally, actual spreads for auctioned securities tend to be particularly low on the auction day when compared with the spreads during the surrounding days. Therefore, the adverse selection argument cannot explain the pattern of abnormal returns.

Third, primary dealers may have had an incentive to influence the aftermarket price before the auction. This may have been easier in the early sample period when there were fewer market participants and the trading volume was lower. Keloharju et al. (2002) show that the Treasury has set the supply of the bonds in such a way that the average spread between the auction stop-out yield and the secondary market yield is more or less constant over time. Therefore, a decrease in secondary market price before the auction could induce the Treasury to sell the bonds cheaper. As explained earlier, in the beginning of the sample period the financing needs of the Treasury may have overridden its concerns for price, and may have made it reluctant to combat the adverse price development by cutting supply.

Although not reported formally, we also investigate the development of other benchmark-adjusted secondary market price series. Bid prices and prices from customer purchase and sales transactions yield similar although somewhat less distinct results. For example, the average benchmark-adjusted bid price change from event day  $-4$  to the auction day for the entire sample period is  $-0.11\%$ . The corresponding numbers for customer purchase and sales prices are  $-0.06\%$  and  $-0.10\%$ , respectively. Except for customer purchases, the price changes are significantly negative at the 5% level.

## 5 Conclusions

In this paper we document a number of basic descriptive statistics from the Finnish Treasury bond market from 1991–1999. Moreover, we assess the gross revenues of the primary dealers for Treasury bonds by investigating the magnitude of redemption fees and sales commissions in the primary market and trading margins in the secondary market. Finally, we analyze the development of the price of the auctioned bonds, relative to other benchmark bonds, around the time of the auction. We report that the price of the auctioned bond series tends to drop before the auction and increase after the auction. This pattern is strongest in 1992-94 when the funding needs of the Treasury were very large and the secondary market trading volume of Treasury bonds was relatively modest. The magnitude of the price change is inversely related to the magnitude of primary dealers' net sales of bonds to their customers.

We have chosen to concentrate on the Treasury bond market, which is the largest component of the Finnish debt market. A more comprehensive account of the revenues of the primary dealers would analyze the Treasury bill market and the market for bond futures. This is left for future work.

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