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Summary

Using data on Government of Canada securities auctions, this paper shows that in countries where direct access to primary issuance is restricted to government securities dealers, Order-flow" information is a key source of private information for these security dealers. Order-flow information is revealed to a security dealer through his interactions with customers, who can place bids in the auctions only through the security dealer. Since each dealer interacts with a different set of customers, they, in effect, see different portions of the market demand and supply curves, leading to differing private inferences of where the equilibrium price might.

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1 Introduction

The asymmetric information view of financial markets posits that financial market participants have access to private information regarding the value of a given security, and use their private information to their strategic advantage. A large theoretical literature is concerned with the question of how market equilibrium will be attained, and how assets will be priced, in the presence of private information and with the strategic use of this information.[1]

What is the source of "private" information in financial markets, especially in the vast markets for government securities around the world? After all, it is difficult to argue that most participants in such markets are privy to much insider information regarding the "fundamentals" underlying the value of a particular government bond. Most, if not all larger players in these markets have access to the same computer screens, and financial and political news data. Hence, aside from possessing heterogeneous priors due to exogenous reasons, the forecasts they will make will differ from each other only to the extent that their forecasting technologies are different.

There is, however, one source of truly "private" information among financial market participants, identified by the market microstructure literature as "order flow." Most large players in financial markets are intermediaries, who buy and sell securities to profit from the bid-ask spread. A source of private information is their interactions with their customers – since each dealer interacts with a different set of customers, they, in effect, see different portions of the market demand and supply curves, leading to differing "private" inferences of where the equilibrium price might lie.

In this paper, we will analyze the role of "order flow" as a source of private information in financial markets, and its consequences regarding the strategic behavior of market participants using a unique data set from the Government of Canada securities auction market. In this market, securities dealers authorized by the Bank of Canada place bids in debt issues of the Government of Canada (GoC henceforth). These securities dealers bid for themselves, but they are also allowed to submit bids on behalf of their customers. Similar to other Treasury auction data sets used in previous microeconomic studies, we have access to the entire set of bids submitted for a set of securities of offerings.[2] A "unique" aspect of our data set is that we are able to observe which bids are submitted by the dealers for themselves and which bids are submitted for their customers. Another "unique" aspect of our data is that, along with the final set of bids, we are also able to track how dealers modify their own and their customers' bids on the Bank of Canada's bid submission database over time.

Given this extremely rich data source, we investigate the following questions:

[1] See O'Hara (1995) and the references therein for a comprehensive account of this theoretical literature.

[2] Empirical studies on Treasury auctions that also have access to bidder-level data are Umlauf (1993), Gordy (1994), Nyborg, Rydqvist and Sundaresan (2002), Hortacsu (2002), Fevrier, Preguet and Visser (2002).

1. Is there evidence for private information in this market? If there is, how does the market mechanism aggregate this information?

2. How much of this private information is due to "order flow"? In particular, do dealers make use of the information contained in their customers' bids, as evidenced by observed modifications in their own bids? Assuming that dealers do modify their bids on the basis of information revealed by their customers, do they make these modifications in a manner consistent with a rational, profit-maximizing agent point of view?

3. It is reasonable to expect that customers know that they are revealing valuable information to their dealers, and will react accordingly. Is there any evidence for strategic behavior on the part of the customers?

Our first set of results, obtained in Sections 4-6, yields that there is a large amount of heterogeneity in the information possessed by different bidders participating in these auctions. In particular, in section 5, we document that there is a large degree of dispersion across dealers bids. In section 4, we document that these dispersed bids are the result of a information gathering process that takes place in the period leading up to the auction. Specifically, we document that official bid submissions are very much concentrated within the last 15 minutes preceding the bid submission deadline. We also document that "later" bids are much better predictors of the auction outcome than "early" bids. We also find bidding activity for long-term securities (bonds) are much more concentrated within the last few minutes of the bidding window, and that this last minute information aggregation phenomenon is much more visible for bonds than for bills. This finding is consistent with the intuition that the valuation of long-term securities is subject to much more uncertainty, and hence, the incremental value, and hence the value of waiting for, new pieces of information to arrive, is larger.

Our next set of results delve deeper into the nature of this information gathering process that precedes the auction. In particular, in section 6, we find strong evidence that dealers delay their own bids until they receive the bids of their customers, who, in turn, wait until the last minutes of the auction to bid. Once again, there is a visible difference between these temporal patterns across bonds and bills: dealers' tendency to "wait" for customer bids is much more pronounced in bond auctions as opposed to bill auctions, suggesting that the information contained in customer bids is more important in bond auctions as opposed to bill auctions.

We then analyze whether dealers indeed incorporate the information contained in customer bids in their own bids. In section 6, we analyze data on modifications in dealers' bids, and, controlling for public information that might be driving these bid modifications, we find that two sources of private information drive these bid changes. The first source of private information is the information contained in modifications to customer bids, which are observed by the dealers through which these customers bid. The second source of private information is the net long or short position of a dealer, obtained throughout the bidding process, through over-the-counter when-issued transactions with customers.

These results suggest that an important source of dispersion in dealers' bids, and hence a source of private information in this market, is the information contained in customer bids. In section 5, we also document that, controlling for size, dealers with access to more customers are better able to predict market outcomes. Hence, we our results are consistent with the simple theoretical intuition that "more information is better" when making decisions under uncertainty.

Next, we focus on the "customer" side of the market. One might expect that customers, especially those with large orders, will realize the strategic value of the information contained in their bids, and react accordingly. In particular, in section 7.2, we observe that some customers spread their bids across several dealers. We also find that customers are more likely to route their bids through more than one dealer when the customer has a large quantity of security to buy (and hence is more likely to "move the market"). this effect is more pronounced for bond auctions compared with treasury bill auctions, replicating the "information gathering" hypothesis across treasury bill and bonds observed in the dealer-side of the market.

An analysis of bids that arrive after the auction submission deadline in Section 7.1, reveals that most of these are dealer bids submitted in bond auctions. Presumably customers hold-off submitting their bids as long as they can; dealers bids that incorporate these customer bids arrive after the auction submission deadline and are rejected. ¡cr¿ Interestingly, we also find in Section 7.3 that some large customers who do not route their bids through multiple dealers in an auction are in long-term relationships with their dealers. Since repeated relationships with a customer provide valuable information to the dealers, it is conceivable that dealers compensate the customers for this information. By looking at the difference in the average price paid and the cutoff price, we find that customers who are in a long-term relationship in the bond sector pay a lower price in bond auctions when they submit tenders through the dealer with whom they are in a long-term relationship, compared with when they submit tenders through other dealers. Customers who have a long-term relationship in the treasury bill sector but participate in the bond auctions, pay a lower price for bonds when they submit tenders through this long-term dealer compared with when they submit tender through other dealers. This price is comparable to that paid by customers with a long-term relationship in the bond sector, for the tenders submitted through the long-term dealer. Finally, customers in a long-term relationship pay a higher price for tenders submitted through the long-term dealer compared to customers who are not in a long-term relationship. This overpayment is greater when the long-term relationship is in bonds compared with treasury bills. It is conceivable that these customers are compensated by the long-term dealer in a sector other than Government of Canada securities. Once gain, the pay-off hypotheses show that the customer-side of the primary market reflects the last minute "information gathering" hypothesis for longer-term securities relative to shorter-term securities formulated from the dealer-side in sections 4-6.

Thus, our results shed light into the workings of the "black box" surrounding the source and aggregation of private information in government securities markets, and the formation of customer-dealer relationships as a response to the exchange of valuable information across these two parties. It also points to one of the benefits of being a dealer, that of having private access to order flow information. Of course, as in any industry with fixed costs, some revenues above marginal cost are needed to sustain entry; hence, one may regard the informational advantage possessed by the dealers as this additional revenue component.[3]

The importance of "order-flow" as a source of private information, and the strategic incentives possessed by dealers or marketmakers in response to having access to order flow information has been recognized by a large theoretical literature in finance (see for example, O'Hara (1995) and the numerous references within). Empirical work on the role played by "order flow" in asset pricing has been conducted in various securities markets. These include foreign exchange markets (Lyons (2001) and the references within, Evans and Lyons (2002), Ito, Lyons and Melvin (1998)), equity trades (Hansch,Naik and Viswanathan (1998)) and option trades (Easley, O'Hara and Srinivas (1998)). Aside from Hansch, Naik and Viswanathan (1998), this literature has used data aggregate, market-level data to investigate the importance of aggregate measures of order-flow and trading activity on asset prices.

Empirical work that is closest to ours has been conducted by Drudi and Massa (2001), who examine the individual trading behavior of government securities dealers on the primary (auction) market and the interdealer exchange, using a detailed fixed-income transaction database from Italy. Their starkest finding is that dealers behave strategically on the interdealer market to manipulate outcomes in the auction market. Massa and Simonov (2001) use the same data source to investigate strategic trading in the interdealer exchange, and find, consistent with our findings, that information gained from secondary market trading can affect bidding behavior in the primary market. Massa and Simonov (2003) document that long-term interactions between dealers leads to the formation of "dealer reputations," which affect the informational content that counterparties ascribe to the trades originating from these dealers.

Our results complement the findings of Drudi and Massa (2001) and Massa and Simonov (2001, 2003) in delving deeper into the sources of private information and strategic behavior in government securities markets, especially in the primary market. Isolating what drives private information is important in these

[3] Aside from setting up the technological infrastructure to participate in these auctions, as discussed in section 2, dealers may be thought of incurring fixed costs due to the regulations they need to comply by. For example, primary dealers are subject to minimum bidding requirements to keep their status, this may be construed as a fixed cost of doing business. Sareen (2002) argues that the primary dealership system, whereby the issuer makes access to advantages conditional on the dealers satisfying obligations is a means to resolve the agency problem between the issuer and the security dealers. When the number of security dealers is small perhaps due to high entry costs on account of obligations that a dealer has to satisfy, this argument becomes especially convincing.

markets, since theoretical and policy analyses regarding the design of the auction and surrounding market rules rely very sensitively on the exact specification of the informational and strategic environment (see Binmore and Swierbinski (2003), Sareen (2003) for recent surveys of the theoretical and empirical literature on the design of Treasury auctions). In contrast to the work of Drudi, Massa and Simonov, however, our analysis focuses on the dealer-customer interaction, rather than the interactions between different dealers.

The structure of the rest of the paper is as follows: in the next section, we describe the institutional arrangement and rules of the Government of Canada securities markets. Section 3 describes our data base, and provides summary statistics regarding the composition of securities and participating firms in this market. Section 4 describes the temporal patterns in information aggregation. Section 5 describes the heterogeneity in dealer bids, and Section 6 provides an explanation for this heterogeneity through customer bids. Section 7 describes customer and dealer relationships in light of the documented information transmission between these parties. Section 8 concludes.

2 The Institution

The Bank of Canada, on behalf of the Government of Canada (GoC henceforth), issues bonds with a maturity of 30, 10, 5 and 2 years, and treasury bills with a maturity of 1 year, 3 months and 6 months.[4] The process for issuing a "typical" GoC debt instrument links *three* markets: the when-issued market, primary market or the auction, and the secondary market. The process begins with government securities distributors (*dealers* henceforth) typically taking *short* positions in the when-issued market through forward contracts with other participants, for the yet-to-be auctioned security.[5] Subsequently, dealers attempt to cover these short positions by buying the security from other dealers in the when-issued market, from the issuer in the primary market, and finally from another dealer in the secondary market after the auction. In all instances, being profit maximizing agents, they will attempt to buy the securities in which they have a short position at the cheapest price.[6] Details of the three markets are given below.

The ***when-issued*** market precedes the auction by a week. Participants engage in forward trading for the yet-to-be auctioned security in the *when-issued* market.

Following the when-issued market is the ***primary*** market, where the Bank of Canada issues GOC securities through a discriminatory price auction. Potential

[4]Treasury bills are zero-coupon bonds.

[5]The Bank of Canada designates certain institutions as distributors of government securities. These institutions are obligated to buy and sell securities to individual investors.

[6]If the price at which dealers buy the securities in which they have a short position is less (greater) than the price at which they have pre-sold the security in the when-issued market, dealers make a profit (loss) ex-post.

bidders in the government securities auctions can be classified into three groups: primary dealers, other government securities distributors and customers, where "other government securities distributors" refers to government securities distributors excluding primary dealers. The *key* distinction between government securities distributors and customers is that the latter cannot bid on their own account in the auction; rather government securities distributors submit bids on behalf of customers. Thus, Government securities distributors submit bids on their account and on behalf of the customers, being "bidders" in the former and "submitters" in the latter case. The distinction between primary dealers and other government securities distributors is that the former are subject to minimum bid obligations, as both "bidder" and "submitter", in the form of a minimum quantity constraint and a binding price constraint.[7] A customer can chose to submit bids through more than one dealer in an auction.

Bids can be submitted as *competitive* tenders and *noncompetitive* tenders, with the **focus** of this paper being on competitive tenders (tenders henceforth).[8] Typically, a participant's tender will comprise of price-quantity pairs, and the participant's *net position* of the yet-to-be auctioned security at the point of time the tender is submitted. Net position at a point in time refers to the participant's net holdings (whether long or short) of the security being auctioned at that point of time. A customer's tender may comprise only price-quantity pairs as a customer has the option of submitting his net positions directly to the Bank of Canada instead of communicating it through the tender(s) he submits through dealers. Participants can **revise** or cancel previously submitted tenders prior to the auction deadline; there are no limits on the number of revisions that an auction participant can make.

Submitted tenders are allotted through a discriminatory price auction.

The *primary* market is followed by trading in an active resale market for the "new issue" called the *secondary* market.

Both the when-issued and the secondary markets comprise the resale market for GOC securities. The resale market can be decomposed into two: the interdealer market and the customer-dealer market. In the customer-dealer market, institutional investors (for example, pension funds, mutual funds) trade with dealers on a bilateral over-the-counter basis over the telephone, with the result of these transactions known only to the two counterparties participating in the transaction. This is in contrast to the interdealer market that operates primarily through electronic interdealer brokers, who post on an electronic screen, bid, offers, and trade outcomes communicated to him by the dealers telephonically, without revealing the identity of the dealer. While only dealers can post quotes or trade through the interdealer brokers, **both** customers and

[7] A primary dealer has to submit his *threshold* bid at a yield which is within 5 cents of the highest accepted yield. A *threshold* bid is a bid that makes the cumulative amount of the quantity bid greater than or equal to a primary dealer's lower quantity constraint.

[8] A *noncompetitive* tender comprises a quantity subject to an upper bound of $3 million, with a participant being allowed to submit a single *noncompetitive* tender.

dealers have **viewing** access to the electronic screens of an interdealer broker via CanPX, a data service that consolidates and disseminates the trade and quote information provided by the interdealer brokers.

3 Data

Our data set captures several aspects of the primary and the resale markets. For the primary market we have data over the period October 1998 to March 2003. For the resale market we have data over the period July 4, 2001 to September 10, 2001, and February 25, 2002 to February 27, 2003. Henceforth, a GoC security will be uniquely identified by it's maturity date and coupon rate if it is a bond, and by a maturity date if it is a treasury bill. An auction will refer to the issuance of a GoC security of a specific maturity range (30, 10, 5, 2 years for bonds and 1 year, 6 months, 3 months for treasury bills), held at a specific time; thus, an auction for a GoC security will be uniquely identified by the maturity range and the date on which it is held.

3.1 Primary Market

Two aspects of the primary market data are distinguished: the hierarchical aspect of the data, and the official *vs* history aspect of the data.

There are three level in our hierarchical data base: auction level, tender level, bid level.

Auction Level

For each auction we have the issue amount; issue date and maturity date of the auctioned security; total amount bid; total amount allotted; cutoff yield; total bid amount at the cutoff yield; coupon rate (if the GoC security is a bond).

Tender Level

For each tender submitted in an auction, we have the following information: tender type (competitive or noncompetitive); time-stamp of the tender indicating the time at which the tender was submitted in the auction; tender status, in that it is a submitted by the participant, cancelled by the participant or rejected by the issuer;[9] identity of the submitter of the tender; identity of the bidder of the tender; participant type of the bidder (primary dealer, other government securities distributor, customer, Bank of Canada) and submitter (primary dealer, other government securities distributor); net position amount

[9]Tenders received before the auction deadline will have a status of "submitted" or "cancelled". A participant can cancel his last submitted tender. No bid level information is available for cancelled tenders. Tenders received after the auction deadline will have a status of "pending submission" or "pending cancellation". These tenders will either be accepted or rejected by the issuer, with a tender beyond the auction deadline usually being accepted by the issuer if it is on account of transmission failure, and rejected otherwise. The former if accepted has a status of "submitted", and the latter if accepted has the status of "cancelled". All rejected tenders have the status of "rejected".

indicating a participant's net holdings of the yet-to-be auctioned security at that time,[10] with the exception of net positions reported directly to the Bank of Canada by a customer;[11] the allotted tenders of each bidder.

Bid Level

We have the bid amount and yield pairs for each tender submitted by a participant; the maximum amount a participant can bid as a "submitter", and as a "bidder"; and the amount allotted to each participant.

In addition to the hierarchical aspect of this data, we also distinguish the official *vs* history aspect of the data. As mentioned before, a bidder can revise a submitted tender before the auction deadline.[12] All tender revisions and the constituent bid level revisions, made by each participant in the auction will be referred to as the history of the auction. For each auction participant, the **unique** tender and the constituent bids in this tender that are used to determine the cutoff yield and the allotment of the auctioned security is referred to as official data.[13] Thus, the official data is a subset of the history data.

4 Temporal Patterns in Bidding Behavior and Information Aggregation

Bank of Canada securities auctions have a fixed bid submission deadline, and bidders are allowed to submit bids for a particular auction two weeks ahead of time. Since our data set includes the time stamps for each tender (official or not) submitted by the dealers, we can analyze the timing of official bid submissions.

In Figure 1, we plot the cumulative distribution function of official bid submission times for different subsamples of our data set. First, observe that bidding activity is very much concentrated within the hour before the submission deadline. Ninety percent of all competitive bids, those that specify a price as well as a quantity, are submitted in the last 20 minutes of the submission deadline. In contrast, observe that non-competitive bids, i.e. those that do not specify a price, tend to come much later than competitive bids. The median

[10] A net position has to reported with a revised tender only if the change in the net position since the last submitted tender exceeds $25 million.

[11] Customers can submit their net positions to the issuer instead of revealing them to the dealer when submitting their tenders through them. This has to be done 30 minutes before the auction deadline unless there is a change in the net position by $25 million, in which case the latest net position reported is recorded. For customers who submit net positions directly to the issuer, only the last net position amount reported by a customer before the auction deadline is available; the history of revisions in the net position is not available.

[12] While the tender revision is to be done before the auction deadline, in blah % of our sample we find the revisions done after the auction deadline.

[13] An official tender is the last submitted or cancelled tender of a participant. While in blah % of the auctions, the official tender is submitted before the auction deadline, we do have cases where the official tender was submitted after the auction deadline. This could be due to transmission, as well as, strategic reasons.

competitive bid comes in 7.9 minutes before the deadline, whereas the median non-competitive bids comes in 26.5 minutes before the deadline.

A similar phenomenon of "last minute bidding" has been documented on Internet auctions by Bajari and Hortacsu (2003) and Roth and Ockenfels (2002). However, Internet auctions are open- ascending auctions where bidders can see and respond to each others bids, whereas Bank of Canada's auctions are sealed bid auctions in which dealers do not observe other dealers' bidding activity. Hence, "hiding information" from rivals, which is the primary explanation proposed by Bajari and Hortacsu (2003), should not be the primary concern of the securities dealers.

One explanation for the last-minute concentration of bids is that, especially for competitive bids, new information is very important in forming expectations about the appropriate value of the security being auctioned. Hence, bidders are reluctant to commit to a price until they are certain that no new information will be released.

An observation that appears consistent with this explanation is the difference between the bid submission times for long-term vs. short-term securities seen in Figure 1. The submission timings for long-term securities are much more concentrated at the very last minutes of the auction, with the median official bid for securities with maturity greater than one year coming 2.5 minutes before the auction deadline, as opposed to 9.3 minutes for securities with maturities less than or equal to one year. Pricing longer maturity securities depends quite sensitively on expectations about the future, and since many more factors enter into forming expectations about the long-term rather than the short-term, one may expect bidding decisions to be more responsive to arrival of new information.

We now bolster the information gathering hypothesis by presenting evidence that later bids are more informative of the auction outcome. To do this, we first categorized official bids in every auction by their submission times by dividing time into 5 minute periods leading up to the deadline. Since bids come in the form of multiple price-quantity pairs, i.e. demand schedules, we calculated the quantity weighted average price by the formula:

$$p^{QW} = \frac{\sum_{i=1}^{K} p_i q_i}{\sum i = 1^K q_i} \tag{1}$$

We then calculate the "informativeness" of each bid by calculating the absolute difference between p^{QW} and the "cutoff" price of the auction, i.e. lowest price at which the securities were sold. Since Bank of Canada securities auctions follow the discriminatory (pay-your-bid) pricing format, a bidder bidding right at the "cut-off-price" will make the highest profit (assuming, of course, all bidders derive the same value from winning the auction).

Figure 2 plots, as an average over all auctions in our data set, both the number of bids received in each 5 minute time interval, and their "informativeness," as measured by the absolute difference between the bid price and the cut-off price. Observe first that, consistent with the discussion above, many more bids arrive late than early. Observe also that the average "absolute prediction error" of bids declines from 15 basis points at the 30 minute mark to 2.5 cents within the last 5 minutes. This suggests that the early bids, on average, reflect valuations that are quite far from the "average market sentiment" reflected in the cut-off price in the auction.

In figure 3, we see that this "information aggregation at the last-minute" phenomenon is much more pronounced for long-term securities than for short-term securities auctions. In this figure, we compare a normalized informativeness measure across these two types of securities, where we compute the ratio: $\frac{|p_t^{QW} - p^{cutoff}|}{|p_{5mins}^{QW} - p^{cutoff}|}$, i.e. the ratio of the absolute prediction error of the bids that are submitted at time t, and the absolute prediction error of the bids that are submitted in the last 5 minutes of the auction. Observe that this ratio is constant around 1 for short-term securities auctions, suggesting that earlier bids are as good predictors of the auction outcome as later bids. In contrast, for longer term securities, bids that come in more than 30 minutes before the auction deadline have absolute prediction errors that are 10 times as large as bids that come in the last 10 minutes.

5 Dispersion in Dealers' Bidding Performance

One explanation for the temporal patterns described in the previous section is that bid submissions respond to *publicly observed* information flows. All dealers taking part in the Bank of Canada securities auctions have access to global and local financial news sources, and can monitor trading activity between dealers on the electronic interdealer trading platforms.[14] Since dealers acting strategically to maximize profits from the auction will try to make use of all the information they can get, they will wait until the last possible moment to cumulate these pieces of public information in their bids.

If all bidders have access to the same publicly available information, we might expect them to submit very similar bids in the auction, or, at least, give similar bids on average (i.e. there might be random deviations in each bidder's strategy from auction to auction, but, on average, bidders will submit price bids that are similar). The numbers in Table 1 (predictiondispersion.pdf), however, suggest otherwise. In this table, we calculated the absolute value of the difference between each dealer's quantity-weighted price bids and the cutoff price of the auction. We then averaged these "prediction error" measures over our subsamples of auctions of securities with similar maturities. The results in Table 1 suggest substantial dispersion in the cutoff-price prediction performance of the 21 dealers in our data set. In particular, the standard deviation of the dealers' performance is almost as large as the mean absolute prediction error.

[14] The electronic interdealer market accounts for 86% of the volume traded on the interdealer market.

What may explain this large dispersion across dealers' bidding performances? If all bidders have access to the same information sources, and all of them value the security in the same way, it is difficult to fathom that they would bid prices that are very different from each others. Hence, one explanation is that different bidders have access to different, private information sources. Another explanation is that some bidders are simply better at utilizing (possibly publicly available) information to make a forecast about the auction cutoff price. This differential in forecast ability may come from having better skilled traders, or having better organizational decision making capabilities. There may also be a fixed cost associated with utilizing econometric/statistical technology to make forecasts. Hence, this second explanation may suggest a connection between bidder performance and the size of the bidder's operation.

We now investigate the determinants of the dispersion in the prediction performance of the dealers. The first step of this exercise is summarized in the series of regressions reported in Table 2. In the first column, we sought the correlation of dealer prediction performance with the (log) average size of the quantity bids placed by the dealer *for its own account* across all the auctions in our data set. Controlling for categorical variables accounting for different maturity levels, we find that dealer size is actually positively correlated with the size of the average prediction errors. This result appears contradictory with a theory of bidder performance in which size would become positively correlated with bidding performance through forces of competitive selection.

However, note that the "size" variable we have selected are the dealer's own bids, submitted, presumably, for speculative purposes. Another, perhaps more important, source of revenue for a dealer is to intermediate transactions by its customers who do not have direct access to bidding. The advantage from intermediating customer bids is that a dealer has the opportunity to get a "second opinion" as to what the market's valuation of the security being sold. Hence, the more "second opinions" that a dealer gets, the better its forecast may become.

One could easily rationalize this intuition with a standard Bayesian updating model of expectation formation, in which the dealer has a prior belief about the unknown security value, v, where the prior has mean μ and variance σ_v^2. Suppose the dealer also has a private signal about the security value, x, which is distributed about the true value of the security with mean zero error, i.e. $x = v + \varepsilon_x$, where ε is distributed with zero mean and variance $\sigma_{\varepsilon_x}^2$. If all of the aforementioned random variables are distributed normally, conditional on this private information, the dealer expects the value of the security to be:

$$E(v|x) = \frac{\tau_v}{\tau_v + \tau_{\varepsilon_x}}\mu + \frac{\tau_{\varepsilon_x}}{\tau_v + \tau_{\varepsilon_x}}x \qquad (2)$$

where $\tau_v = \frac{1}{\sigma_v^2}$ and $\tau_{\varepsilon_x} = \frac{1}{\sigma_{\varepsilon_x}^2}$, are the precisions of the prior and private signals respectively.

Now, if the dealer receives another signal about the security's true value, in the form of a customer bid, for example, she will incorporate this information into her conditional expectation. Specifically, call this piece of information y, where $y = v + \varepsilon_y$, also distributed with mean zero noise about the true security value. Given y, the conditional expectation becomes:

$$E(v|x,y) = \frac{\tau_v}{\tau_v + \tau_{\varepsilon_x} + \tau_{\varepsilon_y}}\mu + \frac{\tau_{\varepsilon_x}}{\tau_v + \tau_{\varepsilon_x} + \tau_{\varepsilon_y}}x + \frac{\tau_{\varepsilon_y}}{\tau_v + \tau_{\varepsilon_x} + \tau_{\varepsilon_y}}y \tag{3}$$

i.e. a simple linear combination of the different pieces of information that the bidder received, weighted by their relative precisions.

It is also easy to see that the variance of this conditional expectation as an estimate of true value of the security, v, is lower when the dealer observes the additional piece of information y, as opposed to when she does not. In particular, the variance of the estimator should decline with the number of independent additional signals that the dealer observes.

The second and third columns of Table 2 appear to provide support to this intuition. In the second regression to explain differences in cutoff price prediction performance, we add a variable for the log of the average size of the customer bid relayed by the dealer. As suggested by the discussion above, the size of customer bids is negatively correlated with the prediction error. The addition of this variable appears also takes away some of the significance of the positive "own size" effect.

In the third column, we also add the (average) number of unique customers that a dealer serves into the prediction performance regression. We find that the coefficient on the number of unique customers is negative and significant at the 5-percent level, with the estimate suggesting that an additional customer reduces mean absolute prediction error by 9 cents! Interestingly, the negative coefficient on customer order size loses its significance, and declines in value, suggesting that the number of independent opinions contained in the customer opinions may matter more in decreasing predictive performance than the size of the customer orders.

The final column of Table 2 investigates a comparative static suggested by the discrepancy in temporal bidding patterns across long-term and short-term securities that we found in the previous section. Recall that we argued that the temporal patterns suggested that "information gathering" played a more important role for longer maturity securities than for short-term securities. If this argument is correct, we should also expect the "predictive advantage" from having an additional customer's opinion to be higher in longer maturity securities auctions than in short maturity auctions. Indeed, in the regression we run in the fourth column of Table 2 finds that the coefficient on the number of unique customers served by a dealer, is significantly negative only when interacted with an indicator for long-maturity securities auctions. The coefficient estimate suggests that for securities with maturity above 1 year, an additional customer accounts for an improvement in prediction accuracy of up to 24 cents –

a rather large number when compared to the performance differentials reported in Table 1.

A final note about the regression in Table 2 is the interpretation of the positive coefficient of the dealer's own "size" variable. A dealer's demand for a given security may possess a private value component, as well as a pure common value component, as modelled above. For example, as is the case in Canada, a primary dealer may have to fulfill a minimum bidding requirement to preserve its privileged position. Hence, the primary dealer may find it necessary to knowingly bid above the cutoff price to fulfill this requirement. This would, of course, degrade the dealer's prediction performance as measured here. Since primary dealers are also the largest dealers in the market, this behavioral bias may explain the persistent positive correlation between size and prediction performance.

6 Dealer Bidding Behavior and Customer Orders

We now present more direct evidence for the hypothesis that found substantial support in the analysis of the previous section: "Dealers bid differently because they have access to different information sources. Two important sources of private information are customer bids and the forward (short or long) position of a dealer."

We will present two sets of evidence. We will first contrast the submission timings of dealer bids with the submission timings of customer bids, and present evidence that dealer bids lag customer bids. We will then argue that dealers' price bids reflect the informational content of customer bids, by showing that innovations in dealer bids follow innovations in customer bids very closely. We will also show that dealer bids are affected by the dealer's net short or long position.

6.1 Do Dealer Bids Follow Customer Bids?

Table 3 displays evidence for the hypothesis that dealers will submit their own bids after seeing customers' bids. To construct this table, we looked at all instances in which a dealer submitted own her own behalf as well as for a number of customers. We then compared the submission time of the latest customer bid to the submission time of the dealer's own bid using a pair-wise t-test (i.e. the within dealer difference). The test, when conducted for the entire spectrum of maturities reveals that dealer bids lag the latest customer bid by 0.43 minutes, the difference being statistically significant at the 1.7% level. Furthermore, we find that dealer bids lag customer bids 55% of the time.

However, as the next column of Table 3 shows, the difference in the timing between dealer and customer bids do not appear to statistically different for short-term securities. Dealer bids lag customer bids 52% of the time – not visibly (or, as it appears, statistically) different from an even split.

In contrast, dealer bids appear to lag customer bids much more visibly in auctions for longer-term securities. Not only both customer and dealer appear to come much later for these auctions, as was found in Section 4.1, dealer bids, on average, are submitted 2.5 minutes later than the latest customer bid. The lag is statistically significant at the 1% level. Moreover, dealer bids lag customer bids 74.9% of the time in these auctions.

Hence, the evidence suggests that dealers react to the information contained in their customers' bids *when and where it matters.* In particular, the second and third columns of Table 3 confirm our findings so far regarding the difference in the importance of "customer information" across longer term vs. shorter term securities auctions. Granted, given that customer bids also come very near the bid submission deadline, one may suspect that dealers will have little time to perform elaborate calculations. However, our data suggests that, on average, a minute or two appears to suffice.

6.2 Do Dealer Bids Respond To the Informational Content of Customer Bids?

We now investigate whether dealers change their bids in response to the arrival of customer bids, and whether the direction and magnitude of this change is explained by the informational content of the customer order. To do this, we utilize the bid history aspect of our data set, which comprises of *all* bids submitted by the dealers, not just the official bids. This allows us to track the modifications that dealers make in their bids on Bank of Canada's computerized bidding system.

To calculate modifications in dealers' bids, we fix a time interval, starting $T = 10$ or $T = 30$ minutes prior to the bid submission deadline, until the submission deadline. We then calculate the "standing bid" of the dealer at time T, which is the dealer's most recent bid as of time T. However, the dealer can change this bid until the bid submission deadline. Thus, we find the dealer's "official" bid, i.e. the final bid by the dealer that is accepted by the Bank of Canada. We then calculate the difference between the (natural logs) of the dealer's official bid and her standing bid at T minutes prior to the deadline. Since bids comprise of multiple price-quantity points, we take the quantity-weighted average price as the bid.

We then perform the same calculation for the customers, taking the (log) difference between their official bid and their standing bids at T minutes prior to the bid submission deadline. Thus, the change in a dealer's information set between time T and the auction deadline includes these modifications in customer bids.

Another piece of information that the dealer obtains within this time period is through the over-the-counter customer-dealer market, where the dealer engages in forward short or long trades. Unfortunately, we do not have access to this trading information. However, since by law dealers have to report changes in their net long or short positions to the Bank of Canada along with any changes to their bids, we observe net impact of this trading activity through modifications to the dealers positions. Again, we code these modifications as the difference between a dealer's "standing" net position at T minutes prior to the deadline, and the net position reported along with the dealer's official bid.

Aside from these two sources of information, which are privately observed, dealers may also modify their bids within the last T of an auction due to news coming from public information sources. Moreover, customers may also be modifying their bids in response to the release of the same public information – hence an observed correlation between dealer bid modifications and customer bid modifications may be due to the fact that both parties are responding to the same information source (the forward position of a dealer may also be responding to public information). Hence, we have to control for the presence of public information within the chosen time interval to identify a causal relationship between customer bid modifications and dealer bid modifications.[15]

We do this by utilizing an auction-level fixed effect specification. This amounts to looking at the variation across dealer bid modifications in the last T minutes *within a given auction*, and how much of this variation is explained by customer bid modifications observed by each dealer in this time period. One weakness of the auction-level fixed effect specification is that it assumes that the linear relationship between dealer bid modifications and customer bid modifications (and net position changes) is the same across different auctions in our data. We relax this assumption somewhat by conducting our analysis on Treasury bills and bonds separately.

Table 4 reports the results of the auction-level fixed effect regressions. The dependent variable in this table is the modification in a dealer's bid during the last 10 or 30 minutes of an auction. Note that in both time intervals, modifications in customer bids are positively and significantly correlated with modifications in dealer bids. The point estimates imply that a 1% increase in customers' price bids within the last 10 minutes implies a 0.297% increase in the dealer's bid. Within the last 30 minutes, the effect is smaller – a 1%

[15]We should note that most Central Banks including Canada, set auction deadline timing so that it does not coincide with major news releases like monetary policy target or income and employment data. However, it is possible that other sources of financial news, such as developments in U.S. financial markets, may affect asset prices in Canada. One way to control for the presence of public information flows is to proxy for this using real-time trading prices for securities that might be close substitutes to the security being auctioned. We actually observe this additional piece of data. In Canada, CanPX a data service, consolidates trade and quote data submitted by Canada's fixed income electronic interdealer-brokers. This information is disseminated to both customers and dealers.[16] Potentially, both customers and dealers could track the impact of any publicly observed information shock on prices right uptill the auction deadline, and consequently make modifications in the bids they submit in the auction. However, when we looked at CanPX data to extract proxies for public information flows. Even though we have documented that 99% of the bid modifications are made in the last 30 minutes before the auction deadline, for each auction in the sample, we looked at CanPX data for a two-week window prior to the auction coinciding with the time when the when-issued market commences. We observed **no** trade or quote activity for the yet-to-be-auctioned security in the entire period covered by our sample. This empirical fact was puzzling given that the basis for a when-issued market is price discovery. However, these results are consistent withe the findings of Drudi and Massa (2001) that dealers try to hide orderflow information from other market participants in the Italian market for government securities.

upward revision in customers' bids translates into a 0.094% upward revision by the dealer. However, the fact that the correlation between dealer bid revisions and customer bid revision within the last 30 minutes is smaller than in the last 10 minutes is consistent with the observation that few customers are active at the 30 minute mark – thus modifications in these bids do not affect the dealer's bid as much as modifications by customers who arrive later. In fact, if when we compared the number of "strategic" customers (defined as those who modified their bids at least once within an auction) who were active (i.e. had submitted a bid) at $T = 10$ vs. $T = 30$, we found that more such customers were active at $T = 10$ as opposed to at $T = 30$.

When we conduct the auction-level fixed effects regression for the subsamples of Treasury bills and bonds separately, an interesting pattern emerges that appears consistent with our previous findings. We find that for both the $T = 10$ and $T = 30$ time intervals, the correlation between dealer bid modifications and customer bid modifications is much stronger in bond auctions than in Treasury bill auctions – in fact, the correlation in Treasury bill auctions is very near zero in both time intervals (although the correlation in the $T = 30$ interval for bonds was estimated with low precision owing to the small sample size, the point estimate is of the right sign). This is consistent with our earlier results suggesting that information contained in customer bids matters much more in bond auctions (which are harder to price since bond prices are, presumably, subject to more uncertainty) than in Treasury bill auctions.

Our regressions also indicate that changes in net positions of a dealer are important drivers of modifications in the dealer's bid. Once again, the effect appears much stronger in bond auctions as opposed to Treasury bill auctions – this is most likely due to the fact net positions, and thus net position changes in bond auctions are much larger (about 20 times) than in Treasury bill auctions (which is also driven by the fact that bond auctions are typically much larger on average than bill auctions). As for the sign of the estimated coefficient it is interesting to note the sign change across the last 10 minutes vs. the last 30 minutes in the (bond) auctions. Intuitively, it is not entirely clear what sign we should expect: assuming that the auction price is positively correlated with the secondary market trading price of the security, one might expect a dealer with a large short position to try to bid low so as to depress prices in the resale market, so that she can cover her short positions at as low a price as possible. On the other hand, one might expect a dealer with a large short position to bid high in the auction to cover as much of her short position to avoid being squeezed in the secondary market. Based on our results, unfortunately, we can not tell between these two possible hypotheses.

Taken together, the results of this section and section 5 suggest that customer bids provide private information to dealers and that dealers make use of their ability to observe customer bids. We also note that interactions with customers through forward (when-issued) transactions also drive dealer bids in this market.

7 Customers Respond to Dealer's Use of Order-Flow Information

In the previous sections, by looking at the dealer-side of the primary market, we found considerable support for the hypothesis that an important source of private information for dealers is customer bids, and that dealers use customer bids to revise their opinion about where the cutoff price in the auction might be. In this section we present evidence to support this hypothesis from the customer side of the primary market. Customers realize that dealers through whom they submit bids, revise their opinion about where the cutoff price will be, on the basis of customer bids. We present three features of customer bidding behaviour, which can be viewed as strategic responses of customers to bid revision by dealers on observing customer bids.

In section 7.1, we investigate the hypothesis that by holding-off bid submission till just before the auction deadline, customers can try to prevent dealers from making strategic use of their order flow information. Since a dealer wants to condition on as much customer information as possible, customers may try to push a dealer "beyond the deadline" by submitting their bids at the last minute, and force the dealer to risk giving his own bid later than the deadline. In Section 7.2, customers attempt to conceal their entire demand schedule from a single dealer by using multiple dealers to submit bids. In Section 7.3 we show that some customers are in a long-term relationship with a dealer in that they use a distinct dealer to submit their bids across all auctions. Presumably these repeated interactions provide dealers with valuable information about the cutoff price in the auction, for which they are likely to compensate the customers. We find that the payoff to the customer takes the form of the customer paying a lower price for the securities at the auction when he submits bids through his long-term dealer compared with other dealers, reflecting that the tendency to revise bids by dealers is less pronounced when the dealer's bid revision is conditional on the bid of a customer with whom he is in a long-term relationship. Finally, in parallel with the difference in the "information gathering" hypothesis between bonds and treasury bills, formulated in Section 5, we find that the strategic responses of the customer to bid revision by the dealer are much more pronounced in bond auctions compared with treasury bill auctions.

Thus, the customer-side of the primary market reflects the "information gathering" hypothesis formulated from the dealer-side in sections 5-6.

7.1 Last Minute Bidding by Customers Leads to Late Bids by Dealers

In Section 6.1 we observe that while customer bids lag dealer bids, customer bids come quite close to the submission deadline as well. A possible reason for this could be that customers attempt to conceal their demand curves from dealers as long as they can, as they realize that dealers will use these to revise their own bids. We now look at late tenders to investigate this proposition: do customers bid close to the submission deadline to prevent dealers from revising their bids on seeing customer bids. Late tenders will refer to bids that arrived after the official bid,[17] and were rejected by the issuer for being submitted after the submission deadline.

If customers could indeed prevent dealers from using their orderflow information by holding-off submission of their bids till just before the submission deadline, we would expect to see a significant number of late bids from dealers: dealers bids that incorporate the last-minute bids of customers arrive after the submission deadline, and are rejected. We actually find evidence to the contrary. Only 1% of the total tenders, and 2% of the official tenders submitted by the dealers were late. However, the fact that we see so few late tenders does not necessarily contradict our hypothesis that customers bid close to the auction deadline to conceal their demand curve from dealers. This is because a customer also knows that a bid that she submits too close to the submission deadline has a higher likelihood of not being transmitted by the electronic auction system, as the dealer through whom this bid has been submitted has hit his submission limit, the maximum amount he can bid as a submitter.[18] In this instance bidding too close to the submission deadline would mean that the customer does not participate in the auction, and will have to buy the security at a higher price in the secondary market that follows the auction. If she has a large order, which is when she will attempt to bid as late as possible, the consequence of not participating can be particularly severe as this customer could be potentially "squeezed" in the secondary market.

Evidence that is more in line with the hypothesis that customers bid close to the auction deadline to prevent dealers from revising their bids emerges, when we look at the bidders from whom the late bids originate, and the auctions where the late bids are submitted. In case customers bid close to the bid submission deadline to prevent dealers from revising their bids on seeing customer bids, we should find that most of the late bids are dealer bids. We find that this is the case. 77% of the late tenders were submitted by the primary dealers and 13% by the customers.[19]

Finally, late bidding should be more pronounced for bond auctions rather than treasury bill auctions as there is greater uncertainty in pricing the former, and hence the tendency by customers to conceal their bids till the end should be more pronounced for bond auctions than treasury bill auctions. This is supported by the data as well. We find that the proportion of late tenders in

[17]The official bid of a participant refers to the tender of this participant that is used to determine the cutoff yield.

[18]When a dealer submits a bid on behalf of a customer on the electronic auction system, and including this bid the dealer has bid in excess of the amount he is permitted as a submitter, the auction system automatically does not transmit this bid and flashes this message on the dealer's screen. Since these bids are not entered in the auction system, they are not recorded, and we could not analyze them.

[19]The difference is statistically significant at the 99% level with the test statistic, Z=7.9.

bond auctions is more than double that in treasury bill auctions.[20] In addition late tenders were submitted in twice as many bond auctions compared with treasury bill auctions.[21] If the value of orderflow information is greater in bond compared with treasury bill auctions as we have hypothesized, then we should find that the difference in the amount paid by the bidders when the status of the late tenders is changed from rejected to accepted is significantly greater for bond rather than treasury bill. We find this to be the case with the former being thrice the latter.[22]

Thus, although there is some suggestive evidence that customers may be bidding close to the submission deadline to prevent dealers from revising their bids upon observing customer bids, though the evidence is far from being conclusive.

7.2 Multiple-Submitter Customers

In Section 7.1 we observe one aspect of strategic bidding by customers to conceal their demand curves from dealers: customers wait as late as they can to submit bids. In this section, we establish a second dimension of strategic bidding by customers: customers submit bids through more than one dealer to avoid revealing their demand curve to a single dealer.

There are two types of customers in our sample in terms of the average number of dealers through whom a customer submits bids in an auction. Table 5 plots the frequency distribution of customers in terms of average number of submitters used in an auction. It shows that about 10% of the customers used more than one submitter in an auction. Henceforth, customers who have a submitter average in an auction greater than or equal to 1.5, will be referred to as multiple-submitter customers, and those who have a submitter average of less than 1.5, will be referred to as single-submitter customers. This section establishes that multiple-submitter customers submit bids through more than one dealer to avoid revealing their demand curve to a single dealer as they realize that dealers use customer bids to form an opinion about the cutoff price at the auction.

Customers appear to use a larger number of dealers to submit bids when they have a larger quantity of the security to buy. Let S_t^i indicate the number of submitters used by customer i in auction t, q_t^i the total quantity demanded by customer i through all submitter used by the customer in auction t, and IA_t is the amount of the security issued in auction t. We also define MPS as the marginal propensity to submit,

$$MPS = \frac{\Delta S_t^i}{\Delta \frac{q_t^i}{IA_t}}.$$

[20] For bonds, late tenders as a proportion of the number of auctions in the sample was 0.64; for treasury bills the corresponding proportion was 0.31. The difference is significant at 99% with the test statistic, Z=4.3.

[21] Late tenders were submitted in 50% of the bond auctions in the sample, and only 25% of the treasury bill auctions. The difference was significant at 99% with the test statistic, Z=3.4.

[22] The difference is significant at the 95% level.

Column (1) of Table 7 reports the regression of the number of submitters, S_t^i, on the proportion of bid amount to issue amount, $\frac{q_t^i}{IA_t}$; the slope coefficient in this regression is the marginal propensity to submit. Customers use an additional dealer to submit tenders for a 36% increase in the ratio of bid amount to issue amount, with this coefficient being significant.

In general, a customer could be using multiple dealers as submitters in an auction due to either one or both of two effects: "concealing effect" or the "submission limit" effect. "Concealing effect" refers to a customer using multiple submitters in an auction to conceal his full demand curve from a single submitter. "Submission limit" effect refers to a customer using multiple submitters in an auction due to a binding constraint on a dealer as a submitter described in Section 2.

A first test, which indirectly supports the hypothesis that multiple-dealer customers submit bids through more than one dealer predominantly due to the "concealing effect", is based on a comparative static that exploits the differences in the temporal bidding patterns established for the dealer-side of the market in the previous sections. Our results suggested that "information gathering" by dealers from customers through which dealers obtain "second" opinion about the cutoff price price, played a more important role for bond auctions compared with treasury bill auctions. If these results were supported by the customer-side of the market, the tendency to use a larger number of dealers in response to quantity demanded due to the "concealing effect" should be much more pronounced for bonds than treasury bills. That is, the marginal propensity to randomize should be greater for bonds than for bills for all customers. We re-run the regression in Column (1), Table 7 by interacting the ratio of bid amount to issue amount with an indicator for bond auctions. Results in Column (2), Table 7 show that this is the case. For bond auctions, customers use an additional dealer to submit tenders for a smaller increase in the ratio of bid amount to issue amount compared with treasury bill auctions, and the difference is statistically significant.[23] But this result could also suggest that customers demand is higher in bonds relative to treasury bills, and therefore it is the "submission limit" effect that leads them to submit bids through multiple dealers. We find the reverse: the ratio of bid amount to issue amount is 10% higher for treasury bills than bonds, and this difference is statistically significant.

A second test of the hypothesis that multiple-dealer customers submit bids through more than one dealer predominantly due to the "concealing effect", is based on a comparative static that exploits the difference in the marginal propensity to submit of single-submitter and multiple-submitter customers, in auctions where they submit bids through two or more dealers. In these auctions, both multiple-submitter customers and single-submitter customers use more than one submitter; but the former do it due to both the "concealing effect" and

[23] For bond auctions, customers use an additional dealer to submit tenders for a 24% increase in the ratio of bid amount to issue amount, and for treasury bill auctions they use an additional dealer for a 40% increase in the ratio of the bid amount to issue amount.

"submission limit" effect, and the latter do so only due to the "submission limit" effect. Thus, for each additional dollar of the security demanded, a multiple-submitter customer will spread his bids across a larger number of submitters than a single-submitter customer reflecting that multiple-submitter customers use more than one submitter due to both the "concealing effect" and "submission limit" effect, whereas single-submitter customers use more than one submitter only due to the former. In short, a larger MPS of multiple-submitter customers relative to single-submitter customers in auctions where both use two or more dealers as submitters, supports the hypothesis that multiple-dealer customers submit bids through more than one dealer predominantly due to the "concealing effect".

Before testing this hypothesis, we need to control for customers who participate only in a few auctions in the sample. Customers who participate in less than 20% of the auctions of a specific security will be referred to as passive customers, and those who participate in more than 20% of the auctions of a specific security will be referred to as active customers.[24] A test based on the comparison of the MPS of single-submitter customers with that of multiple-submitter customers, but without controlling for the presence of passive customers, may not be conclusive. This follows from the proportion of passive customers to total customers being significantly greater for single-submitter than multiple-submitter customers as documented in Table 6, and passive customers bidding differently from active customers. Since they participate in so few auctions, it is conceivable that passive customers do not learn that dealers are likely to use their orderflow information to revise their opinion about the cutoff yield; hence they do not use multiple submitters. In addition, we also find that passive customers demand smaller quantities than active customers on an average.[25]

Controlling for passive customers, the regression in Column (1) of Table 6 is re-run to test for "concealing effect" and "submission limit" effect hypothesis. The sample consists of official tenders of customers in auctions where they use two or more dealers as submitters. Column (3) reports the results of this regression, with rows 2-5 reporting the MPS of multiple-submitter active, single-submitter active, multiple-submitter passive and single-submitter passive customers, respectively. While multiple-submitter active customers use an additional submitter for a 45% increase in the proportion of bid amount to issue amount, single-submitter active customers actually decrease the number of submitters with an increase in the proportion of bid amount to issue amount, with the difference in the MPS being significant.

[24] Auctions for 30 year GOC securities are the least frequent in our sample, with a total of 10 auctions. We need a customer's participation in at least 2 auctions to study strategic bidding across auctions. Thus 20% was selected as the cutoff participation level.

[25] A test of the difference in the average of $\frac{q_t^i}{IA_t}$ between active and passive customers yields a test statistic of 8.79, with $Prob(Z > 8.79) = 0$.

7.3 Customers in Long Term Dealer Relationship

If customers use multiple dealers to conceal their demand schedules from customers, how do we explain the existence of active single-submitter customers? We find that some of the active single-submitter customers are in long-term relationship with their dealers, and are compensated by the dealers for the information provided by these repeated interactions. The payoff to these customers is primarily in the form of these customers paying lower prices at an auctions when they submit bids through the dealer with whom they are in long-term relationship, compared with when they submit bids in the same auction through other dealers. Thus, the bid revision by dealers on seeing customer bids is much more pronounced when customers in long-term relationship submit bids through dealers other than the long-term dealer. In keeping with the difference in "information aggregation" between bonds and treasury bills, we also find that the payoff hypothesis is confined to the bond auctions, with customers who are in long-term relationship in the treasury bill sector being compensated by the dealer in the bond sector.

To show the existence of a **long-term** relationship, we want to show that single-submitter customers who are active submit a large proportion of their bids through a distinct submitter throughout the sample.[26] Thus we are going to concentrate on customers in row 1, Table 5; these customers are single-submitter customers. Single-submitter active customers can be obtained from row 2, Table 6, with the "average" column indicating that 19% of the nonrandomizing customers are active on an average across maturity range. However Tables 5 and 6 do not indicate that when on an average one submitter was used, was that submitter a **distinct** submitter or not, which is what we need to establish the existence of a long-term relationship. Hence, for each of the single-submitter active customers, we construct the ratio of number of auctions in which a specific submitter was used, to the total number of auctions in which the customer participated, for each **distinct** submitter used by a single-submitter active customer. This is referred to as a customer's ***submitter proportion***. For each customer, we tested if the highest and second-highest submitter proportion is significantly different. Customers for whom this is the case are customers with long-term relationship with a specific dealer in that they submit most of their tenders in the sample period through a distinct dealer. Table 8 lists these customers. For example, customer TEA is a single-submitter active customer who has a long-term relationship with dealer WXZ in treasury-bill auctions. TEA participates in 25% of the treasury bill auctions held in the sample period. In 78% of these treasury-bill auctions in which customer TEA participates, he uses dealer WXZ as the submitter.

Having established the existence of a long-term dealer relationship, we now explore what kind of payoffs a customer gets from being in this long-term relationship with a dealer. We test three hypothesis about whether the average price

[26] Passive single-submitter customers are excluded from this exercise as we cannot establish long-run relationship for these customers in our sample period.

paid by a customer differs depending on whether a customer is in a long-term dealer relationship or not.

The **first** hypothesis we test is whether in the sector where there is a long-term relationship, a customer pays a lower price when he submits tenders through the dealer with whom he is in a long-term relationship, compared with the dealers with whom he is not in a long term relationship. Table 9, columns (1) and (2) report the results of these tests. The sample for testing this hypothesis comprises of allotted tenders of only those customers who are in long term relationship, in the sector(s) where there is long term relationship. These tenders could be submitted either through the dealer with whom the customer is in a long term relationship, or through the dealer with whom the customer is not in a long term relationship. For each tender allotted to a customer in an auction,[27] we construct the quantity weighted average price; the difference in quantity weighted average price and the cutoff price of the auction in which this tender was allotted, referred to as mark-up, is our dependent variable. For the regression in Column (1), Table 9, the explanatory variable is a dummy variable ltC_ltD. This variable takes the value 1 if the tender allotted to the customer was submitted through the dealer with whom he is in a long-term relationship, and 0 if it is submitted through any other dealer. While customers in a long-term relationship pay 0.5 cents less when they submit tenders through their long-term dealer compared with other dealers, this difference is not significant.[28]

But we have documented the difference in behaviour across maturity range in the analysis in the previous sections. Exploiting this difference, we re-run the regression in column (1), Table 9 introducing dummy variables for whether the long-term relationship is in the bond or the treasury bill sector. The results of this regression are reported in column (2), Table 9. BD_ltC_ltD (TB_ltC_ltD) is a dummy variable that takes value 1 if a customer in a long-term relationship in the bond (treasury bill) sector, submits the tender through the dealer with whom he is in long-term relationship in that sector, and takes value 0 if the tender is submitted through a dealer other than the long-term dealer. Similary, TB_ltC_nltD is a dummy variable that takes value 1 if a customer in a long-term relationship in the treasury bill sector, submits the tender through the dealer with whom he is not in a long-term relationship in that sector, and 0 if the tender is submitted through the dealer with whom he is in a long-term relationship.[29]

In keeping with the spirit of the results in the previous sections, we now find differences emerging in the pay-off hypothesis, depending on whether the long-

[27] A customer could be allotted more than one tender in an auction as he has the option of submitting his tenders through more than one dealer.

[28] t=-1.21, $Pr(t > 1.21) = 0.89$.

[29] The constant in the regression in column (2) is the difference in the quantity weighted average price and cutoff price of allotted tenders of customers in long-term relationship in the bond sector, submitted through the dealers other than the dealer with whom they are in a long-term relationship in the bond sector.

term relationship is in the bond or treasury bill sector. We find that customers in long-term relationship in the bond sector, pay 3 cents less in bond auctions when they submit tenders through the dealer with whom they are in a long-term relationship compared with submitting tenders through other dealers, and this difference is significant. Customers in a long-term relationship in the treasury bill sector, pay 0.2 cents less in treasury bill auctions when they submit tenders through the dealer with whom they are in a long-term relationship compared with submitting tenders through other dealers; but this difference is not statistically significant.[30] These results hold when we control for differences in the quantity weighted average price and cutoff price between customers, irrespective of whether they submit tenders through long-term dealers or other dealers.[31]

¿From the results in columns (1)-(2), Table 9, we see that customers in a long-term relationship in the bond sector are compensated by the dealer with whom they are in long-term relationship through a lower price compared with when these customers submit tenders through other dealers. This result does not go through for treasury bills. This leads to the question whether customers in a long-term relationship in the treasury bill sector are being compensated in the bond sector by the dealer with whom they are in a long-term relationship. This is the **second** hypothesis we test, with the results for this hypothesis test reported in Table 9, column (5). The sample to test this hypothesis is built as follows. We first isolate customers in a long-term relationship in the treasury bill sector who participate in bond auctions but are not in a long-term relationship in the bond sector. Our sample comprises of allotted tenders of these customers in bond auctions. These tenders could be submitted through the dealer with whom this customer is in a long-term relationship in the treasury bill sector, or through other dealers. A dummy variable, ltD_tb, which takes the value 1 for the former tenders and 0 for the latter tenders, is our explanatory variable.[32] Our dependent variable is the quantity weighted average price minus the cutoff price of the tenders allotted to the customers in our sample. Column (5) reports the results of this regression. Even though the customer is in a long-term relationship in the treasury bill sector, this customer pays 9 cents less in bond auctions when he submits tenders in bond auctions through the

[30] F=0.21, $F(1, 196, 0.95) = 3.84$.

[31] This is done by re-running the regression in column(2), Table 9 after adding a dummy variable for each of the customers listed in Table 8 to the set of explanatory variables in column (2), Table 9. Customers in long-term relationship in the bond sector still pay 3 cents less in bond auctions when they submit tenders through the dealer with whom they are in a long-term relationship compared with submitting tenders through other dealers, and this difference is significant. Customers in a long-term relationship in the treasury bill sector, pay 0.07 cents less in treasury bill auctions when they submit tenders through the dealer with whom they are in a long-term relationship compared with submitting tenders through other dealers, and the difference is not significant. In both cases the significance of the difference, or the lack of it, changes dramatically compared to the results in column (2), Table 9 with t=-12.99 for bonds and $F \approx 0$ for treasury bills.

[32] Thus, the dummy variable takes the value 1 if the customer is submitting the tender in bond auctions through the dealer with whom he is in a long-term relationship in the treasury bill sector. It takes the value 0 if the tender is being submitted in a bond auction through any dealer other than the long-term dealer.

dealer with whom he is in a long-term relationship in the treasury bill sector. In addition, we find that the price paid by these customers in bond auctions is comparable to the price paid by customers in long-term relationship in bond auctions, when they submit tenders through dealers with whom they are in a long-term relationship in the bond sector.[33]

The **third** pay-off hypothesis we test is whether a customer in a long-term dealer relationship pays a lower price compared with customers who are not in long-term dealer relationship, in the maturity sector where the customer is in a long-term relationship. Table 9, columns (3) and (4), report the results of this test. The sample to test this hypothesis is built as follows. ¿From the previous sample, we remove all tenders submitted by the customer through the dealer with whom he is not in a long-term relationship. This gives us allotted tenders of customers who are in long-term relationship, submitted through the dealer with whom they are in long-term relationship, in the sector in which the customer is in a long-term relationship. We add allotted tenders submitted by customers who are not in a long-term relationship in treasury bill and bond auctions. These customers either use more than one submitter in an auction (multiple-submitter customers with a submitter proportion greater than 1), or they use one submitter in an auction, but this submitter is not a **distinct** submitter.

Column (3) reports the results of the regression of the difference of quantity weighted average price and the cutoff price on the dummy variable *ltC_ltD*. This dummy variable takes the value 1 if the tender allotted to the customer was submitted through the dealer with whom he is in a long-term relationship, and 0 if the customer is not in a long-term relationship.[34] In the sector where there is a long-term relationship, customers in long-term relationship when submitting tenders through the dealer with whom they are in long-term relationship, pay 0.5 cents more than customers who are not in long-term dealer relationship, and this difference is significant at the 99% level.[35] In Column (4), Table 9 we run the same regression, but now introducing the distinction between treasury bills and bond auctions. In both the treasury bill and bond sector, customers in long-term relationship when they submit tenders through the dealer with whom they are in long-term relationship, pay more compared with customers who are not in long-term relationship. For bonds (treasury bills), the former pay 1 (0.5) cents more than the latter, and this difference is statistically significant.

This result appears counterintuitive at first in that customers in long-term relationship pay a higher price for Government of Canada securities when submitting tenders through the long-term dealer, compared with customers who

[33]While the former pay 4 cents above cutoff price, the latter pay 6 cents (this is obtained as the sum of the constant and the coefficient of the dummy variable *bd_ltC_ltD* in column (2), Table 9). In addition, the difference is not statistically significant at the 95% level; t=0.63, t(14, 0.95)=1.8, with the t-statistic calculated using pooled variance of the two sample of customers.

[34]The constant in the regression in column (3) is the difference in the quantity weighted average price and cutoff price of the customers who are not in a long-term relationship.

[35]$t = 2.72$, $P(t > 2.72) = 0.997$.

are not in a long-term relationship. What might explain this result? Given the fact that the long-term customer and his dealer interact with each other in sectors other than Government of Canada securities, it is conceivable that the payoffs to the long-term customers are being given in these sectors by the long-term dealer. The second hypothesis tested above suggests that this could be the case. Alternatively, it is conceivable that a customer enters a long-term relationship with a dealer because institutional reasons specific to a customer's business push him to the inelastic part of his demand curve relative to customers who are not in a long-term relationship.[36]

Thus, customers who are in a long-term relationship with a dealer, are adequately compensated by the dealer for the information provided by the customers in repeated interactions.

8 Conclusion

This paper establishes that in the issuance process of Government of Canada securities where direct access to primary issuance is restricted to authorized security dealers, "order-flow" information is potentially the key source of private information for these security dealers. "Order-flow" information is revealed to a security dealer through his interactions with customers, who can place bids in the auctions only through the authorized security dealer. Since each dealer interacts with a different set of customers, they, in effect, see different portions of the market demand and supply curves, leading to differing "private" inferences of where the equilibrium price might lie.

What if this source of private information was "dissipated" through a change in the mechanism to issue government securities? This could happen either by allowing direct access to customers to place bids in the primary issuance, and/or imposing some form of transparency obligations on the authorized security dealers with respect to their secondary market activity. For example, in Italy, the secondary market is transparent in that it is a centralized, regulated electronic screen-based market. However, only authorized dealers are allowed to place bids in primary issuance, and as we point out in the Introduction, Drudi and Massa (2001) show how authorized dealers use the discrepancy in transparency to obtain government securities in the less transparent primary market at below-market prices. In the U.S., customers are allowed to place bids in the primary issuance, making the primary market transparent. But unlike Italy, the secondary market is largely over-the-counter, with the customer-dealer interaction protocol requiring the customer to even reveal his intention to buy or sell when he requests a quote! The Italian and the U.S. comparison, along with several other countries examined by Sareen (2003), highlight that a mechanism for issuing government securities appears to retain privacy of a security dealer's

[36]For example, a customer that is a pension fund could be legally required to hold a certain proportion of its portfolio in the form of Government of Canada securities. This may not be the case for another customer that is a hedge fund.

"order-flow" in *at least* one the markets in which the dealer is participating. Which one will be less costly for the issuer? Which one will increase participation in the primary issuance? These questions will be explored in future research.

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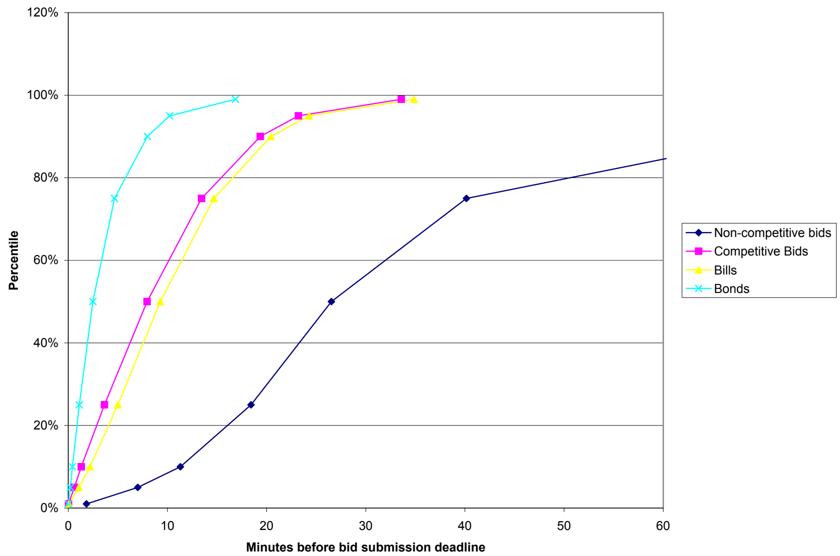

Figure 1: CDF of Bid Submission Times

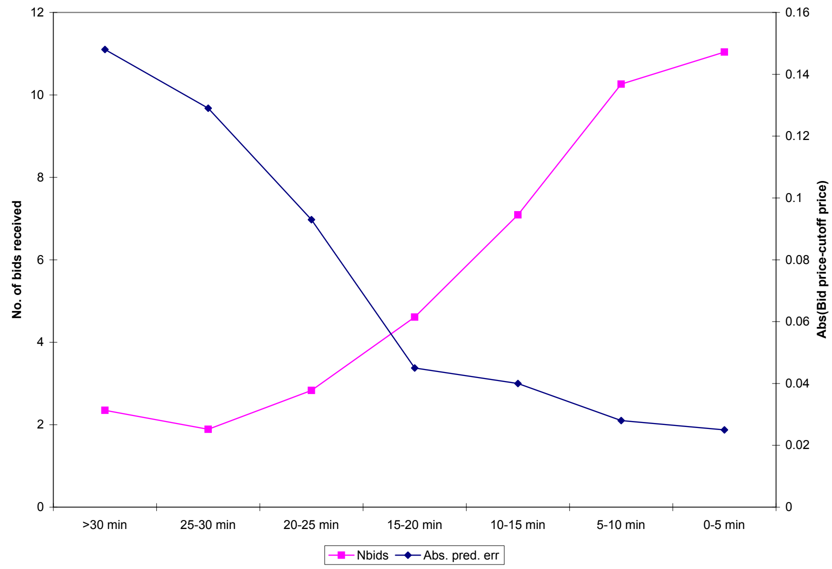

Figure 2: Last Minute Information Aggregation

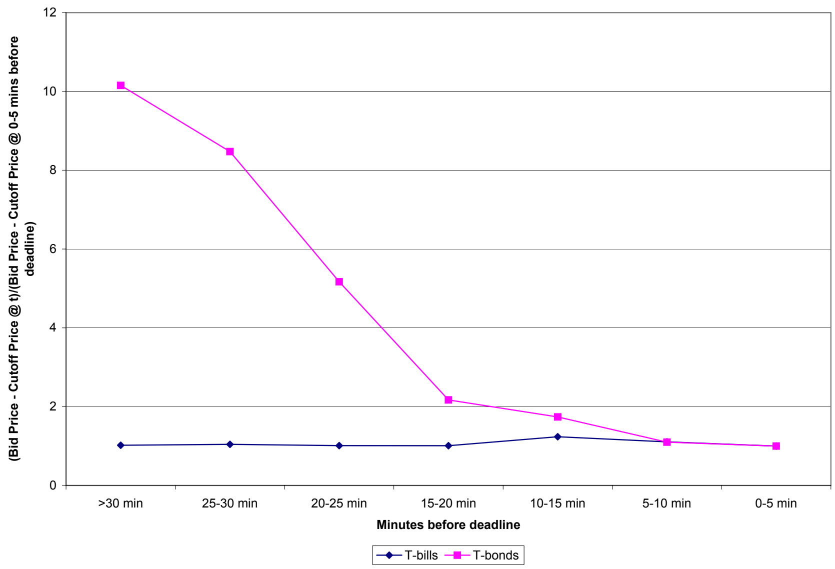

Figure 3: Sensitivity of Last Minute Bidding to Term Type

Table1: Average Absolute Prediction Error

Maturity	# Dealers	Mean (cents.)	Std. Dev. (c	Min (cents)	Max (cents)
1 Month	14	0.38	0.33	0.11	1.11
3 months	17	0.55	0.42	0.18	1.63
1 year	18	1.59	1.22	0.61	5.3
2 years	21	3.72	3.18	0.42	14.72
3 years	21	4.58	4.78	0.96	18.05
5 years	21	8.71	6.04	2.15	24.3
6 years	21	10.37	10.71	1.41	43.18
10 years	21	20.01	20.74	4.66	76.01
30 years	21	45.56	32.49	15.47	146.96

The "prediction error" is calculated, for each auction, as the absolute value of the difference between the dealer's quantity-weighted average price bid and the cutoff price of the auction. This is averaged, for each dealer, over all auctions within the maturity category listed in the table.

Table 2: Prediction Error Regression

	(1) Abs. Prediction Error	(2) Abs. Prediction Error	(3) Abs. Prediction Error	(4) Abs. Prediction Error
log(Dealer Size)	0.016	0.030	0.036	0.001
	(0.006)**	(0.017)*	(0.017)**	(0.038)
log(Customer Size)		-0.027	-0.006	-0.003
		(0.013)**	(0.016)	(0.024)
No. of customers			-0.095	-0.006
			(0.045)**	(0.057)
Bond*Dealer Size				0.046
				(0.042)
Bond*log(Customer Size)				0.005
				(0.032)
Bond*No. of Customers				-0.243
				(0.089)***
Constant	-0.310	-0.126	-0.549	-0.038
	(0.130)**	(0.335)	(0.384)	(0.733)
Observations	175	111	111	111
R-squared	0.52	0.58	0.60	0.64

Standard errors in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Dependent variable is the (averaged over auctions) absolute value of the difference between quantity-weighted price bids and the auction's cutoff price.

Dealer Size is measured as the dollar amount (averaged over auctions) that a dealer placed bids for on its own behalf.

Customer Size is measured as the dollar amount (averaged over auctions) that a dealer placed bids for on behalf of its customers.

Number of Customers is the average number of unique customers that a dealer serves per auction.

Bond is a dummy variable that equals 1 for securities that are more than 1 year in maturity

Maturity fixed effects are supressed

Table 3: Comparison of the Timing of Dealer vs. Customer

	All Maturities	Bills	Bonds
Submission Time of Dealer Bid (minutes from deadline)	8.64 s.d.= 7.92	9.59 s.d.= 8.03	2.27 s.d.= 2.15
Submission Time of Customer Bid (minutes from deadline)	9.08 s.d.= 6.81	9.71 s.d.=6.87	4.81 s.d.= 4.53
Difference	-0.43***	-0.12	-2.54***
Std.err.	0.20	0.23	0.29
P-value	0.02	0.3	0
% of times Dealer Bid precedes Customer Bid	55.29%	52.39%	74.90%
Number of comparisons	2042	1779	263

"Submission Time of Dealer Bids" measures the time, in minutes, before the auction deadline at which the last dealer bid is submitted.
"Submission Time of Customer Bid" measures the time, in minutes, before the auction deadline at which the last customer bid is submitted, for the same auction and same dealer as above.
The reported "Difference" is the result of a pairwise t-test. Standard errors and p-value of the test are reported.

Table 4: What Drives Dealers' Bid Revisions?

Dependent variable: % Change in Dealer's Bid During Period

	Last 10 Minutes of the Auction			Last 30 Minutes of the Auction		
	Entire Sample	T-Bills	Bonds	Entire Sample	T-Bills	Bonds
% Change in Customers'	0.297***	0.0046	0.299***	0.094***	-0.011	0.054
Bids During Period	(0.033)	(0.0074)	(0.098)	(0.016)	(0.050)	(0.049)
(averaged over customers)						
Change in Dealer's	0.0177***	-1.81e-07	0.186***	-0.016***	-0.00037***	-0.015***
Net Position	(0.0057)	(0.00006)	(0.054)	(0.001)	(0.00006)	(0.004)
Number of Unique Customer	0.00003	-1.63e-06	0.00018	0.000059	2.73e-08	0.0004
Bids Received by Dealer	(0.0001)	(1.12e-06)	(0.00089)	(0.00004)	(1.17e-06)	(0.0004)
Number of Customers	0.00009	4.02e-06**	-0.00041	-0.00015	-1.94e-06	0.0016**
Revising Bids During Period	(0.0002)	(1.59e-06)	(0.00110)	(0.000097)	(1.87e-06)	(0.0006)
Observations	1918	1672	246	1909	1667	242
No. of Auctions	213	153	60	213	153	60
Avg. Observations/Auction	9	10.9	4.1	9	10.9	4
R-sq: within	0.0508	0.0048	0.1044	0.1561	0.0201	0.2187
between	0.0372	0.0004	0.0424	0.0370	0.0134	0.0150
overall	0.0533	0.0031	0.1040	0.1427	0.0202	0.1853

Notes: Each column reports the estimated coefficients from a fixed effects regression. The dependent variable is the percent change (calculated as a log first difference) between a dealer's standing price bid at 10 or 30 minutes before the bid submission deadline, and the dealer's official bid. The first independent variable is the percent change between this dealer's customers' price bids during the last 10 or 30 minutes in the auction. The second independent variable is the change in the dealer's reported net long (or short) position during the last 10 or 30 minutes of the auction. We also control for the number of unique customer bids received by the dealer, and the number of customers who revised their bids within the last 10 or 30 minutes in the auction. To purge the effect of public information sources in comovements across customer and dealer bid changes, we control for auction-level fixed effects in the regressions. Standard errors are reported below the coefficients. Significance at 10-percent, 5-percent and 1-percent leves are denoted by *,**, and ***.

Table 5: Frequency Distribution of Customers Who Participated in At least One Auction in Terms of Average # of Submitters

Avg # of Submitters	Bonds	Treasury Bills	Customer Type
< 1.5	74	95	Single-Submitter
1.5 & < 2.5	18	18	Multiple-Submitter
2.5 & < 3.5	6	8	Multiple-Submitter

The numbers in this table referr to unique customer participation and not unique customers. Suppose a customer ABC participates in 30 year bond auctions, and 1 year treasury bill auctions in the sample. Then we obtain the average number of submitters used by this customer in the 30 year bond auction and the 1 year treasury bill auction. Suppose the average number of submitters used by this customer is 3 for the former and 1 for the latter auctions. This customer will then appear in row (1) under the "Treasury Bill" column, and row (3) undeer the "Bonds" column.

Table 6: Active *vs* Passive Customers

	Bond	Treasury Bill	Average
$\frac{\text{\# of multiple-submitter passive customers}}{\text{\# of multiple-submitter customers}}$	0.4	0.57	0.49
$\frac{\text{\# of single-submitter passive customers}}{\text{\# of single-submitter customers}}$	0.82	0.80	0.81

The column "average" is the average ratio across maturity range. The difference in the "average" ratio between multiple-submitter passive and single-submitter passive customers is significant at 1%, with Z = 34.01.

Table 7: Customers Use Multiple Dealers

	(1)	(2)	(3)
$\frac{\text{bid amount}}{\text{Issue Amount}}$	2.6^{**}	2.53	
	(0.403)	(0.41)	
$(\frac{\text{bid amount}}{\text{Issue Amount}})$*(Bond)		1.69^{*}	
		(1.01)	
$(\frac{\text{bid amount}}{\text{Issue Amount}})$*(Multiple-Submitter Active)			2.24^{**}
			(0.8)
$(\frac{\text{bid amount}}{\text{Issue Amount}})$*(Single-Submitter Active)			-3.49^{**}
			(1.04)
$(\frac{\text{bid amount}}{\text{Issue Amount}})$*(Multiple-Submitter Passive)			-2.1
			(1.74)
$(\frac{\text{bid amount}}{\text{Issue Amount}})$*(Single-Submitter Passive)			-8.01^{*}
			(3.68)
constant	1.329	1.32	2.6
	(0.029)	(0.03)	(0.06)
Observations	1413	1413	385
R-squared	0.0285	0.03	0.08
$F^{*}_{msa-ssa}$			24.45^{**}

$**$ significant at 99%; $*$ significant at 95%; standard error are given in parenthesis. Dependent variable is S_t^i, the number of submitters used by customer i in auction t. $\frac{\text{bid amount}}{\text{Issue Amount}}$ is the ratio $\frac{q_t^i}{IA_t}$, the amount bid by customer i in auction t over the amount issued in auction t. (Single-Submitter Active), (Single-Submitter Passive), (Multiple-Submitter Active), and (Multiple-Submitter Passive) are 0-1 dummy variables that take a value of 1 if in auction t, customer i is a single-submitter active customer, single-submitter passive customer, multiple-submitter active customer, and multiple-submitter passive customer, respectively, and zero otherwise. The sample in columns (1)-(2) consists of official tenders of all customers. The sample in column (3) consists of official tenders of all customers in auctions where they submit tenders through two or more dealers. $F^{*}_{msa-ssa}$ is the F-statistic for the difference in the marginal propensity to submit, MPS, of multiple-submitter active and single-submitter active customers.

Table 8: Customers with Long Term Dealer Relationship

Customer	Maturity Range	Submitter	Submitter Proportion	Participation Proportion
TEA	T-Bill	WXZ	0.782	0.245
OEO	T-Bill	DZZ	0.667	0.217
GUO	T-Bill	JDW	0.851	0.566
ZXN	T-Bill	KVY	0.778	0.248
TDI	Bond	DZZ	0.79	0.33
ZAW	Bond	DZZ	0.883	0.286
EQV	T-Bill	KVY	1.000	0.229

Table 9: Payoff to Customers with Long Term Dealer Relationship

	(1)	(2)	(3)	(4)	(5)
ltC_ltD	-0.005		0.005		
	(0.0041)		(0.0016)		
BD_ltC_ltD		-0.03		0.01	
		(0.012)		(0.006)	
TB_ltC_ltD		-0.086		-0.042	
		(0.010)		(0.003)	
TB_ltC_nltD		-0.085			
		(0.011)			
TB_nltC				-0.046	
				(0.0022)	
ltD_tb					-0.09
					(0.059)
constant	0.0137	0.092	0.0067	0.05	0.125
	(0.0036)	(0.01)	(0.0007)	(0.002)	(0.029)
Observations	196	196	896	896	25
R-squared	0.008	0.44	0.008	0.35	0.09
$(ltC\_ltD - ltC\_nltD)$	-0.005				
	(-1.21)				
$(ltC\_ltD - ltC\_nltD)\_BD$		-0.03^{***}			
		(2.55)			
$(ltC\_ltD - ltC\_nltD)\_TB$		-0.002			
		(0.206)			
$(ltC\_ltD - nltC)$			0.005^{***}		
			(2.72)		
$(ltC\_ltD - nltC)\_BD$				0.01^{***}	
				(2.03)	
$(ltC\_ltD - nltC)\_TB$				0.005^{**}	
				(12.22)	
$(ltD\_tb - nltD\_tb)$					-0.09^{*}
					(-1.49)

$***$ significant at 99%; $**$ significant at 95%; $*$ significant at 90%; standard error in parenthesis above the double lines. Dependent variable is the difference in the quantity weighted average price of the allotted tenders and the cutoff price in Canadian dollars. Both the quantity weighted average price and the cutoff price are quoted in terms of $(CD) 100 of the security allotted.

Table 9 continued..

The sample for the regressions in columns (1) and (2) comprises of allotted tenders of only those customers who are in long term relationship, in the sector(s) where there is long term relationship. The sample for the regressions in columns (3) and (4) comprises of: allotted tenders of customers who are in long-term relationship, submitted through the dealer with whom they are in long-term relationship, in the sector in which the customer is in a long-term relationship; allotted tenders submitted by customers who are not in a long-term relationship in either the bond or the treasury bill sector. The sample for the regression in column (5) comprises of tenders allotted in bond auctions to customers who are in a long-term relationship in the treasury bill sector. ltC_ltD takes the value 1 if a customer in a long-term relationship submits the tender through the long-term dealer in the sector where there is a long-term relationship, and 0 otherwise. BD_ltC_ltD (TB_ltC_ltD) is the same dummy variable with the added condition that the long-term relationship is in the bond (treasury bill) sector. TB_ltC_nltD takes value 1 if the allotted tender of the customer in a long-term relationship in the treasury bill sector is submitted in treasury bill auctions through dealers other than the one with whom he is in a long-term relationship, and 0 otherwise. TB_nltC takes value 1 if the allotted tender is submitted by a customer who is not in a long-term relationship in the treasury bill sector, and 0 otherwise. ltD_tb takes value 1 if in bond auctions, the allotted tender of a customer in a long-term relationship in the treasury bill sector is submitted through the dealer with whom he is in a long-term relationship, and zero otherwise. Rows below the double lines compare the difference in the quantity weighted average price of the allotted tenders and the cutoff price, for two sets of customers. Row (1) is this difference for customers in a long-term relationship when they submit tenders through the long-term dealer, compared with when they submit tenders through other dealers, in the sector where there is long-term relationship. Rows (2) and (3) are identical to Row (1), except that they pertain to the long-term relationship being in the bond and the treasury bill sectors, respectively. Row (4) is the difference for customers in a long-term relationship when they submit tenders through the long-term dealer, compared with customers who are not in a long-term relationship, in auctions belonging to the sector where there is long-term relationship. Rows (5) and (6) are identical to Row (4), except that they pertain to the long-term relationship being in the bond and the treasury bill sectors, respectively. Finally, row (7) pertains to customers who are in a long-term relationship in the treasury bill sector; it is the difference in the quantity weighted average price and cutoff price of tenders submitted in a bond auction through the dealer with whom they are in a long-term relationship in the treasury bill sector, compared with any dealer other than the long-term dealer. Rows (1)-(3), rows (4)-(6), and row (7), test the first, third, and the second pay-off hypothesis described in Section 7.3. Test statistics for testing the significance of the difference across two sets of customers described above, are given in parenthesis.

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(lix) This paper was presented at the ENGIME Workshop on “Mapping Diversity”, Leuven, May 16-17, 2002

(lx) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications”, organised by the Fondazione Eni Enrico Mattei, Milan, September 26-28, 2002

(lxi) This paper was presented at the Eighth Meeting of the Coalition Theory Network organised by the GREQAM, Aix-en-Provence, France, January 24-25, 2003

(lxii) This paper was presented at the ENGIME Workshop on “Communication across Cultures in Multicultural Cities”, The Hague, November 7-8, 2002

(lxiii) This paper was presented at the ENGIME Workshop on “Social dynamics and conflicts in multicultural cities”, Milan, March 20-21, 2003

(lxiv) This paper was presented at the International Conference on “Theoretical Topics in Ecological Economics”, organised by the Abdus Salam International Centre for Theoretical Physics - ICTP, the Beijer International Institute of Ecological Economics, and Fondazione Eni Enrico Mattei – FEEM Trieste, February 10-21, 2003

(lxv) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications” organised by Fondazione Eni Enrico Mattei and sponsored by the EU, Milan, September 25-27, 2003

(lxvi) This paper has been presented at the 4th BioEcon Workshop on “Economic Analysis of Policies for Biodiversity Conservation” organised on behalf of the BIOECON Network by Fondazione Eni Enrico Mattei, Venice International University (VIU) and University College London (UCL) , Venice, August 28-29, 2003

(lxvii) This paper has been presented at the international conference on “Tourism and Sustainable Economic Development – Macro and Micro Economic Issues” jointly organised by CRENoS (Università di Cagliari e Sassari, Italy) and Fondazione Eni Enrico Mattei, and supported by the World Bank, Sardinia, September 19-20, 2003

(lxviii) This paper was presented at the ENGIME Workshop on “Governance and Policies in Multicultural Cities”, Rome, June 5-6, 2003

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(lxx) This paper was presented at the 9th Coalition Theory Workshop on “Collective Decisions and Institutional Design”, organised by the Universitat Autònoma de Barcelona and held in Barcelona, Spain, January 30-31, 2004

(lxxi) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications”, organised by Fondazione Eni Enrico Mattei and Consip and sponsored by the EU, Rome, September 23-25, 2004

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