The Market Microstructure of Dealership Equity and Government Securities Markets: How They Differ

Toni Gravelle*

Financial Markets Department
Bank of Canada

(e-mail: tgravelle@bank-banque-canada.ca)

Abstract

This paper examines the structural differences that exist between multiple dealer equity and multiple dealer government securities markets. Although government and multi-dealer equity securities markets have, on the surface, similar market structures, we demonstrate that there are nonetheless some subtle differences between these markets that are likely to significantly impact the way market-makers trade and as such have an impact on the liquidity that they provide. In doing so we review some of the concepts recently introduced in the literature examining multi-dealer equity markets and delineates the various gaps that exist in this literature in terms of its applicability to government securities markets.

---

* This study is intended to make the results of Bank research available in preliminary form to otheranalyst to encourage discussion. The views expressed are those of the author. The analysis and conclusions offered in this study do not represent the official views of the Bank of Canada or the Department of Finance

.

1. Introduction

Until recently, much of the research concerned with the microstructure of securities markets had concentrated on equity markets. Given the fact that research has mainly focused on equity markets, it should come as no surprise to find that market microstructure research has, in general, been heavily weighted towards the development of *asymmetric information models* in which a subset of the market participants have private (insider) information about the asset's (expected) value. The preponderance of asymmetric information models is itself the result of the bias in market microstructure research towards the price discovery process in equity markets. The fact that a stock's fundamental value will likely depend on factors that are idiosyncratic to the firm and that changes in these factors are not disseminated to the public on a continuous basis, guarantees a dominant role for asymmetric (insider) information in the trading process.

Across developed economies, one observes two predominant types of equity markets; order-driven, auction-agency markets and dealership markets. Order-driven markets or order-book markets, such as the Paris Bourse, are structured as (two-sided) auctions in which there is no intermediary. Incoming orders submitted to the market are either "matched up" with offsetting standing orders previously submitted to the market and placed in an electronic order book, or are themselves placed in the book until such time an offsetting order is submitted. Although there has been considerable amount of research carried out examining both types of equity market structures, a large proportion of the equity *dealership* models have focused on a particular equity market, the NYSE. Because the NYSE is a specialist (single dealer) market, most of the dealership models in the market microstructure literature assume a single dealer equity market rather than a competitive *multiple* dealer market such as the NASDAQ in the US and the London Stock Exchange (LSE). The dearth of microstructural research on multiple dealer equity markets has been reversed recently with the work of Hansch et al. (1998), Reiss and Werner (1998), and Viswanathan and Wang (1998a, b) to name a few.[1]

An interesting result of this recent work analysing multiple dealer equity [and foreign exchange (FX)] markets is that the dealers' inventory management behaviour plays an important role in these markets. This revives a second (earlier) strand of microstructure research known as *inventory models*. In these models, dealers adjust their quote and trading behaviour to restore their inventories to some desired level. The innovations brought forward by this recent burst of research, is that dealers are assumed to be risk averse and that dealers trade in a strategic manner to extract information from other dealers.

What is striking in the field of market microstructure research is how little work has been done analysing the microstructure of bond markets. This has endured despite the size and importance of sovereign government securities (GS) markets, generally the largest segment of a developed country's fixed-income or bond market. Fortunately GS markets in most developed countries are structured as multiple dealer markets and function in many ways like multiple dealer equity markets. However, there remain several important differences between GS and equity dealership markets that may make results garnered from the recent multi-dealer equity research inapplicable to GS markets. The purpose of this paper is to examine the differences that exist between equity dealership markets and GS markets. This is motivated by the desire to gather a better understanding of the factors affecting the liquidity and efficiency of GS markets. As discussed in Gravelle (1999), well functioning GS markets play a key role in the maintenance of a stable financial system.

Rather than simply delineating the various aspects and factors underlying the differences between two securities markets, we also review some of the recent literature in order to provide some assessment of the applicability of this literature to GS markets. In doing so we illustrate the gaps that exist in the academic microstructure literature in terms of modelling the trading structure in GS markets and, in

[1] An important contributor to this line of research is Richard Lyons whose work has spawned a burst of empirical and theoretical microstructure research investigating the multi-dealer structure of foreign exchange markets. See Lyons (1995, 1996), for example.

some instances, offer some suggestions for future research directions that would prove most useful in enhancing our understanding of the factors underpinning the market-makers' incentive to trade.

The remainder of paper is organised as follows. Section 2 examines the differences that exist in terms of the securities' intrinsic features such as the securities' predisposition to public versus private information, its maturity characteristics and its hedgability. Section 3 focuses on issues related to market transparency. We examine the subtle structural differences that exist between GS and equity dealership markets and describe how there exist a relationship between the decentralised nature of GS markets and the level of transparency observed in these markets. In the final section, we concentrate our discussion on the factors affecting the level of inter-dealing trading such as, volatility in customer order arrival and sizes, how this volatility relates to the optimal market structure, non-price competition for order flow, and the interaction of a dealer's market making activity with her proprietary trading activity. A unifying theme across these issues is that they all impact market-maker behaviour in some way and as such have a potential impact on the price discovery process or the level of market liquidity observed in dealership markets.

2. Differences in the intrinsic features

In this section we examine some of the differences in the intrinsic features embodied in equity and government securities that have an effect on their tradability or on the trading behaviour of market participants (market-makers and customers alike). We focus on three intrinsic characteristics: the private information embodied in each type of security, the security's finite maturity, and the degree of homogeneity within each class of securities.

2.1 Insider information and payoff-relevant private information

Although it is quite natural to assume an asymmetric information-trading environment for equity markets, this is not a natural assumption in the case for GS markets. It is unclear to what extent there exists private information about the value of government securities. Prices for GS are dependent on the term-structure of the underlying risk-free interest rates. These rates, in turn, depend on macroeconomic factors about which investors will not have private information. In GS markets, private information about the asset's (expected) value, what Cao and Lyons (1998) define as *payoff-relevant private information*, is likely to play a relatively minor role in the agents' trading behaviour. Thus, one of the differences in the intrinsic characteristics of equity and GS is the amount of payoff-relevant private (or insider) information that is embodied each type of security. GS hold, what one can safely assume for modelling purposes, zero payoff-relevant private information, while equity securities hold some positive amount of private information. This implies that traditional market microstructure asymmetric information models based on the prevalence of investors who are better informed than dealers, are likely ill suited to describe the trading environment of the GS market. Moreover, this implies that variance in bid-ask spreads (and liquidity) are unlikely to be related to the clustered arrival of informed public investors in certain periods.

If insider information is of little concern for market-makers in GS markets, then what are the factors influencing their bid-ask spreads and in turn their provision of liquidity? Part of the answer seems to lie in a second, older and, until recently, less developed branch of the market microstructure literature. In this literature, the focus is on the market-maker's inventory management behaviour and assumes that market-makers stand ready to absorb or, more precisely, *temporally* intermediate temporary imbalance between total demand and supply for a security. In these *inventory models*, market-makers "charge" investors the bid-ask spread in compensation for costs associated with providing immediacy

(liquidity).[2] Generally, the bid-ask spread in inventory models depends on the market-maker's level of risk aversion, the asset's riskiness, the market-maker's market power, and, in certain models, her inventory level.[3] Fleming and Remolona (1999) show that in the market for US Treasury securities, price changes can occur - in tandem with public information releases - without any trading taking place. This is in stark contrast to asymmetric information models discussed above where it is the sequential arrival of orders that moves the price of the stock towards its (new) equilibrium (fundamental) value. Moreover, Fleming and Remolona show that market-makers tend to widen their spreads in response to sharp price movements, a natural tendency for market-makers concerned with the higher inventory risks engendered by greater price volatility. This implies that liquidity in GS markets is closely linked to the market-maker's inventory risk management costs which are, in part, subsequently linked to variations in the market-maker's level of risk aversion and GS price volatility.[4]

2.2 Maturity

In the previous section we argued that one of the intrinsic differences between equity and government securities was their private, payoff-relevant information content. Another intrinsic difference between the securities, that has an impact on the trading decision of the market participants and in turn on the security's liquidity characteristics, is their maturity. We start by noting that stocks have an infinite maturity while government debt securities have a finite maturity. What kind of impact does this have on their liquidity characteristics? We argue below that the GS' fixed maturity date generates two classes of investors into the security. The existence of two investor types, in turn, has an impact on the number of securities available for trade, which has an impact on the security's liquidity characteristics. The existence of two types of GS investors implies that there is a *floating supply* of the security available for trading before its maturity date that is less than the total amount issued to the public.

A finite maturity structure for a security implies that investors have the option of liquidating their position in that security at a *known* maturity date, rather than liquidating their position sometime before that date via the (secondary) market. This implicit option is not available for equity investors who must always liquidate the stock in the market and in turn incur some market trading costs. Moreover, the equity investors' holding period, as is normally the case for all utility maximising agents, is conditional on the stock's expected return at any given time, which is in turn dependent on the stock's price and the agent's private information and expectations at that time. On the other hand, a government debt security provides the investor with the outside option of fixing her holding period to a known date. This optionality drives a wedge in the pool of available GS investors thus generating two types of investors: buy-and-hold and trading market participants. The predetermined liquidation date and liquidation value of the debt security gives investors the option of *locking away* these securities in their portfolios till maturity, which in turn reduces the supply of the security available for trading purposes. Specifically, there is a large pool of investors that not only derive utility from a fixed-income instrument's (expected) return but also derive utility from the fact that of the instrument's cash flow stream and/or liquidation value is *known* (ex ante).[5] In sum, the fixed maturity

---

[2] A sample of inventory models is contained in O'Hara (1995) which includes Ho and Stoll (1983) and O'Hara and Oldfield (1986). Note that Madhavan and Smidt (1991) develop an empirical structural model that incorporates both adverse selection characteristics and certain aspects of the (specialist) inventory model to empirically describe the trade-by-trade price process.

[3] O'Hara and Oldfield (1986) show that the combined uncertainty related to both "end-of-day" inventory position and the value of this inventory position induces the spread's dependence on the level of inventories. However, most inventory models find that the spread is independent of inventory level, though placement of the spread is not.

[4] Fleming and Remolona (1999) also show that in GS markets, public information precipitates above average trading volumes theorised to be associated with uniformed liquidity traders (i.e. traders who trade in reaction to public information, in order to rebalance their portfolio for example, rather than trading on private information).

[5] Singleton (1995) describes how institutional investors that revile their portfolios on a regular basis tend to be active market participants while those that do not, tend to be buy-and-hold investors. The latter type of investor may be discouraged from selling the bond (due to accounting practices) at a price that does not lie between the purchase and par

date of a GS opens up the possibility that the supply of the GS available for trading - *the floating or effective supply* - is less than the total (outstanding) supply, which is not the case for equities.[6] Moreover, since the value of the "outside option" of a known holding period increases as the maturity date approaches, the amount of the security in the hands of the buy-and-hold investors will tend to increase, causing the floating supply of the government security to fall over time.

Decreasing floating supply has a detrimental impact on the liquidity of the security both in terms of trading intensity and bid-ask spreads. The smaller number of securities in the hands of trading market participants tends to have a direct negative impact on the trading intensity of the security.[7] In turn, market-makers find it more difficult to carry out their inventory-control activities as trading activity decreases with the drop in floating supply. Specifically, as floating supply decreases, the implicit costs incurred by market-makers increase, since they must wait a longer period of time for the arrival of (and/or must increase their search efforts for) rebalancing orders that move them back towards their desired inventory level.[8] In other words, dealers find it increasingly costly to temporally intermediate transactions.

2.3 Inventory hedging characteristics

One of the intrinsic properties of GS inventories versus equity inventories is that there is a far greater number of instruments available to hedge GS inventories. The market-maker's inventory risks associated with holding a specific government bond can be hedged using a variety of instruments. Market-makers can borrow or lend the same security in the Repo or lending markets, they can hold the opposite position of a nearly identical bond (one with a similar duration), or they can offset this position with a position in the related futures contract. Alternatively, the market-maker could simply try to rebalance its inventory position to reduce its risks. For equity market-makers, avenues for hedging their inventory balances in a specific stock are, for all but the most actively traded, much more limited. Often the only inventory risk adjustment available to equity market-makers is to rebalance their inventory. The major difference is that equity market-makers cannot in general hedge their inventory by taking an opposite position in a similar stock nor can they find a near perfect hedge using a futures contract. These strategies are not available to equity market-makers because there are no instruments (another stock or a futures contract) which are sufficiently correlated to the stock's price. This contrasts with GS where the yield movements for most cash instruments move in a correlated fashion. For example, when macroeconomic news is released, most of the GS yields (within a certain sector of the yield curve) move in the same direction and by a near equivalent amount (in yield terms) such that the (historical) relation between these securities' yields remain relatively constant. As such, with this high correlation in yield movements, market-makers can easily find a large list of other GS in which to take an opposite position to offset an inventory imbalance in a specific security. This homogeneity in yield movements can even be applied to the greater set of cash

---

(maturity) value and, as such, tend to be buy-and-hold investors. Singleton argues that a greater proportion of buy-and-hold investors reduces the floating supply of bonds in the market.

6 One should note that some firms may choose to hold (or repurchase) a proportion of their own stock, thus allowing for the amount of the stock available for trading to differ from the total amount of issued stock. However, since the firm's objective in holding some of its stock is to maximise its price, it avoids reducing the supply of the stock to the point of affecting liquidity. Further, it should be clear that a floating supply of GS arises endogenously out of the utility maximising behaviour of the investors and not the issuer.

7 Amihud and Mendelson (1986) show that there is in equilibrium a positive correlation between trading intensity (defined as the number of transactions observed over a certain period) and trading volume.

8 Further, one should note that any permanent decrease in the security's liquidity will increase the costs associated with actively trading the instrument and, as such, increase the likelihood that investors holding the security will hold it until maturity. This drop in liquidity tends to decrease the floating supply of the security which in turn tends to re-enforce the decrease in liquidity. Moreover, due to positive participation externality effects on other traders (noted by Harris (1993) among others), any decrease in floating supply may have a greater than one-for-one negative impact on the customer activity observed by the market-makers.

fixed-income instruments. That is, in general even bonds issued by a variety of non-government issuers will move in a manner that holds their historical yield spreads off government bonds relatively constant (at least at a daily frequency). This allows market-makers in a specific corporate bond, for example, to sell short a government security as a hedge when they are holding a long position in a corporate bond. Moreover, these same market-makers can often use a position in a GS futures contract to hedge their position in the corporate bond.

The greater homogeneity among GS in terms of yield dynamics, in the end implies a greater ease of inventory price hedging for the GS market-makers relative to their counterparts in equity markets. This, as we will expand on further in Section 4, makes GS dealers able to endure greater extremes in their inventory balances relative to equity market-makers.

3. Decentralised markets and transparency

As opposed to single dealer markets, such as the NYSE, market-makers in multiple dealer markets must directly compete for their share of the order flow.[9] Moreover, competing dealers have the option of laying-off (gathering) unwanted (wanted) inventory by trading with other dealers, thus being able to share their inventory risks across the market-maker community, rather than being constrained to rebalance their inventories by waiting for the arrival of customer/public orders, as is generally the case for the NYSE specialist. As such, there are at least three facets of multiple dealer markets that cannot be adequately captured in specialist based theoretical models. First, there is the competition for customer order flow that exists between multiple dealers. The second is the existence, in most multiple dealer markets, of two parallel trading environments: a public trading environment where customers trade exclusively with market-makers, what we call the public sphere, and an inter-dealer trading environment, what we call the inter-dealer sphere. This implies that a dealer in multiple dealer markets has the option of managing her inventory via transactions with other dealers rather than waiting for the arrival of offsetting customer orders. Third, there is the further segmentation of the inter-dealer trading environment into two trading mechanisms. In this environment, the dealers have the choice of either trading bilaterally with each other or trading indirectly with each other anonymously via an inter-dealer broker (IDB) system, which resembles the auction agency trading structure found in many order driven exchanges.[10] Although these three facets of multiple dealer markets are generally applicable to both equity and GS dealership markets (and FX markets as well), one should note that in certain equity or GS markets, the services provided by a system of IDBs is offered by an electronic auction agency system instead.[11]

Although we discuss in greater detail various aspects of these three facets that relate to transparency regimes, inter-dealer trading, and the decentralised nature of the GS market in the sections that follow, we digress in order to examine the current state of research on multiple dealer markets. Given the relatively complex nature of the two-sphere trading environment for multiple dealer markets (also called a two-tiered or two-stage trading environment), it is perhaps not surprising to see how state-of-the-art research on multiple dealer markets remains rather underdeveloped. A sample of multi-dealer models includes Ho and Stoll (1983), Leach and Madhavan (1993), Perraudin and Vitale

---

9 Specialist also face competition of a similar nature. They must compete with the order book, which lists all standing limit orders. However, the competition is on, to a certain extent, the specialist's terms. That is to say, since the specialist observes all the order flow for the stock (including that to the order book), she can set its bid and ask price based on its knowledge of the order flow she observes.

10 See O'Hara (1995) for a review of order driven auction agency markets.

11 Instinet (and/or SelectNet) essentially provide the same anonymous inter-dealer trading services as a system of IDBs for the NASDAQ equity market. The electronic MTS system in the Italian GS market provides anonymous inter-dealer trading there. And, as of October 1997, the SETS electronic system serves basically the same function as the discontinued IDB system for the 100 most liquid stocks on the LSE.

(1996), Vogler (1997), and Naik et al. (1998). There are various problems with these models that make them of somewhat limited use in capturing the various complex features of multiple dealership models. For example, even though the paper by Ho and Stoll (1983) was seminal in terms of being the first to model inter-dealer trading, it nevertheless assumed a high degree of transparency in the trading environment. Specifically, it is assumed that transactions, and thus dealer inventories, are assumed to be public information. Secondly, Ho and Stoll (1983) assume that both customer trades and inter-dealer trades are carried out in an identical manner via the public sphere which, as described above, does not capture the essence of the parallel trading environment that exists in most multiple dealer markets. Although the more recent theoretical work on dealership markets has relaxed some of these simplifying restrictions, it has in general, failed to combine both private information and risk averse market-makers in one model, features we have argued above to be essential to GS markets. Moreover, most models that do examine private information focus on payoff-relevant private information, which is not necessarily a feature of GS markets. In the following subsections we consider how the decentralised nature of GS markets differentiates them from equity dealership models and how the opaque nature of decentralised markets introduces a role for payoff-irrelevant information in the strategic behaviour of market-makers.

As mentioned in Section 2, in contrast to equity securities, payoff-relevant private information about the value of a GS is unlikely to be important in the provision of market liquidity and the price discovery process. However, the multiple dealer market structure described above does nonetheless allow for information asymmetries to be a prevalent feature of GS markets. That is to say, although GS market participants are unlikely to have superior (or private) information about a security's payoff (or fundamental value), it does not preclude certain agents, namely market-makers, from having private information about the state of the trading environment, such as customer order flow, that will help them better predict the intervening price movements. Cao and Lyons (1998) define this class of information as *payoff-irrelevant private information* and show that this type of information asymmetry, coupled with a market-maker's risk aversion, is an essential determinant of the price discovery process in decentralised multi-dealer markets such as GS markets.[12] Payoff-irrelevant private information is, in principal, also prevalent in equity dealership markets. But the impact of this type of information asymmetry on the trading process is likely to be less than in GS markets given the public investor access to payoff-relevant private (insider) information and, as described below, the equity markets' greater degree of order flow transparency. Using market microstructure terminology, this implies that market-makers are much more likely to be the "informed agent" in GS dealership markets than their counterparts in equity dealership markets.

3.1 Decentralised versus centralised markets

One factor that differentiates multiple dealership GS markets from multiple dealership equity markets is the fact that dealership equity markets (such as the LSE and NASDAQ) are centralised, while multiple dealership GS markets are decentralised. We differentiate between decentralised and centralised markets by the degree that information is available to the public (both customer and dealers alike) on a consolidated basis. For example, even though NASDAQ operates as an over-the-counter (OTC) market, it is nonetheless linked together electronically such that price and trade information can be viewed on a consolidated basis by any investor wishing to transact in this market. This includes pre-trade information (bid and ask quotes across dealers) and post-trade information (data on completed trades in the market). Here "consolidated basis" means, that price and trade data from the spectrum of dispersed dealers is available on a single screen. For example, multiple dealer quotes on NASDAQ are generally available to the public in a consolidate format, such as on a single Bloomberg

[12] Lyons (Chapter 4, 1999) provides an excellent discussion of the drawbacks of the two traditional approaches to market microstructure theory: information and inventory models. He also shows how models based on payoff-irrelevant private information induced asymmetries and dealer risk aversion bridges the gap between the two traditional approaches.

page.[13] However, this is not generally the case for GS markets. GS markets (and fixed-income markets more generally) are also multiple dealer markets, but in contrast to the NASDAQ and the LSE, these markets tend not to be linked up electronically. Rather, investors in GS markets cannot easily ascertain what is the best, most current bid-ask spread being offered by the population of dealers. In principal, the only way for an investor to ascertain which dealer has the best quotation in a decentralised market, would be to directly contact each dealer. Therefore, given the decentralised nature of GS markets, it is possible for simultaneous transactions to occur at different prices and, more importantly, at prices other than the best available price across a spectrum of market-makers.

3.2 Transparency in multiple dealer markets

Before moving on to a comparison of equity and GS market transparency, we should define what is meant by an increase in market transparency. Generally, a market is more transparent when the amount of data on the market's internal trading processes available to the public increases. However, as is the case for market liquidity, measuring the degree to which a market is transparent is no easy task. The problem lies in the fact that market transparency is multi-dimensional and goes beyond simply measuring quote and trade data. Although a market participant's trading behaviour is generally dependent on the quotes she observes and on the execution price of the most recent transaction(s), her behaviour also depends on trader identity, trade size, how long it took the trade to get executed, the size of limit orders that may (or may not) exist, etc.[14] Thus, increases in publicly available data on dealer quotes or transaction prices would only imply an increase in transparency if the other dimensions of market transparency were held constant across the regimes.

Existing research on market transparency tends to be arranged around questions relating to *pre-trade transparency* and *post-trade transparency*. In the case of multiple dealer markets we find it helpful to make the following distinctions. A market is classified as being pre-trade transparent when traders (customers and dealers alike) can directly view *all*, or at a minimum the best, firm bid-ask quotations offered by the spectrum of market-makers. Therefore, a key feature of a pre-trade transparent market is that market participants can, at all times, see all prices that are available and have access to, or can trade at, the best available price. In some of the literature, there is a distinction made between the public display of the best bid-ask quote versus the display of all quotes, with markets that provide consolidated access to all quotations described as more transparent than those that simply display the best prices available. Given the scope of this study, we find it unnecessary to make this distinction. Post-trade transparent markets, on the other hand, are classified as those that report *all* completed trades to the public immediately.[15]

In terms of *pre-trade transparency*, equity dealership markets such as NASDAQ and the LSE are superior to GS markets. This stems from the centralised nature of the equity dealership markets where dealer quotes are reported on a *consolidated* basis.[16] Given the decentralised nature of most GS

---

[13] NASDAQ offers three levels of information access. Public investors have access to level 1 terminals that allow them to observe (real-time) best bid-ask prices.

[14] For an example of research investigating the effects on market liquidity of a regime change in transparency arising from a reduction of available information on trader identity, see Scalia and Vacca (1999).

[15] More generally, pre-trade transparency refers to the amount of information provided about available bid and ask prices and volumes, and how widely accessible this information is to all market participants. Post-trade transparency refers to the extent of information available on the completed transactions (including price, volume, trader identity), and how fast this information is released to market participants. See Pagano and Röell (1996) for some post- and pre-trade transparency definitions.

[16] Flood et al. (1997) argue that limit order book (or auction agency) markets such as the Toronto Stock Exchange or the Paris Bourse may be viewed as more pre-trade transparent than equity dealership markets, since market-makers displaying firm quotations, for example on the LSE's SEAQ display, can improve upon their bid or ask price in telephone negotiations, while limit order prices are not negotiable. Alternatively, given the fact that there is a time lag between submitting a market order and its execution, and that the limit order book is very likely to have changed by that time,

markets, *consolidated* pre-trade quote information is generally not available to public market participants. Therefore a key factor underlying the degree of pre-trade transparency in dealership markets tends to be the existence of a system that *consolidates* (links electronically) the individual dealer quotations and that this system be available/accessible to all potential market participants.

In terms of *post-trade transparency*, the existence of a consolidating (electronic) display system also allows for greater disclosure of completed transactions. However, it is ultimately the regulatory framework that ensures that completed transactions are disclosed to market participants in a timely fashion.[17] For example, it is the Securities Exchange Commission (SEC) that mandates the quick reporting of all trades in the US This is the case for the NASDAQ market where all trades (public and inter-dealer trades alike) are disclosed immediately and in no event later than 90 seconds. The LSE has a slightly lower level of post-trade transparency in which all small trades are reported immediately while larger trades can be delayed by up to 90 minutes.[18] In general for GS markets, given the lack of a consolidating data display system and the lack of a regulatory mandate for the reporting of transaction data, post-trade disclosure to the public of *all* transactions is generally non-existent.

The low degree of transparency in decentralised markets causes the services provided by inter-dealer brokers (IDBs) in those markets to take on an added dimension when compared to the services provided by IDBs in centralised markets. IDBs provide a degree of centralisation in markets that, when viewed from the public's perspective, are completely decentralised. Although it is only the dealers who have access to consolidated information via IDBs, the decentralised market is nonetheless more centralised than if the services provided by IDBs did not exist. One distinction between decentralised versus centralised markets is that *all* completed trades, including those carried out via an IDB type system, must be disclosed to the public (via the market's display system) in centralised equity dealership markets.[19] In decentralised markets, such as most GS markets (and FX markets), IDB transactions are only disclosed to the dealers who have access to the IDB systems thus increasing the informational advantage that GS dealers have over the public traders relative to their counterparts in centralised equity markets.[20] The transparency provided by the IDB systems does indirectly benefit

---

Flood et al. (1999) argue that dealership markets are more pre-trade transparent than order-driven markets. Specifically, "in quote-driven markets, investors trade against outstanding prices, while in order-driven markets, participants must submit orders first, after which prices are determined." (p. 39). These seemingly contradictory results only serve to highlight the difficulty involved in assessing a market's degree of transparency.

17 We also allow that some level of regulation is also necessary to ensure a certain level of pre-trade transparency. However, we would argue that the market-makers incentive structure is such that they require more regulatory prodding to disclose post-trade information than post pre-trade data. Given this, the existence of a system that displays quote data on a consolidated basis plays a greater role in determining the level of pre-trade transparency than the regulatory framework.

18 Flood et al. (1997) make the point that the degree to which post-trade transparency is directly linked to the degree to which the market supports centralised order processing. They argue that electronic or floor-based trading such as the NYSE or Paris Bourse provide a higher level of post-trade transparency than the LSE or NASDAQ since the order flow must pass through a centralised exchange. They indicate that it is difficult to enforce strict post-trade disclosure in dealer markets because larger trades tend to be conducted bilaterally over the phone, and must be reported to the authorities (consolidating display system). In this circumstance, it is difficult for the authorities to confirm the exact time of the trade. In fact, there are incentives for dealers to delay their reporting. Flood et al. (1997) explain that the endemic practice of "protected trading", where dealers provisionally agree to trade at a price, but only finalise the transaction after they have had the opportunity to pre-position their inventories, allows dealers to circumvent publication rules. Although the findings of abundant protected trading on the LSE by Board and Sutcliffe (1995) and Reiss and Werner (1998) is expected, given the LSE's delayed disclosure rules, the findings of Porter and Weaver (1998) indicating that dealers on the NASDAQ systematically delay trade reporting, is surprising and is inconsistent with the reporting guidelines of the SEC. All in all, when judged against the post-trade transparency of electronic or floor-based exchanges with centralised order processing, Flood et al. (1997) argue that NASDAQ and the LSE can be viewed as being strictly less post-trade transparent markets. Given the fact that all transactions do (eventually) get reported to the public, which is much more than can be said about GS or fixed-income markets, we maintain the view that GS markets are not post-trade transparent in relation to equity dealership markets.

19 Note that the equity market display system may not necessarily distinguish IDB trades from dealer-public trades.

20 The GovPX display system for U.S. Treasury securities can be viewed an exception in that inter-dealer quotes placed on IDBs are in fact disclosed to the public.

the customers (the public sphere) in that it reduces the divergence in quotations provided to them by dealers. Under the assumption that dealers compete for a share of market-wide order flow, the dealers will tend to minimise the difference between the (transparent to dealers) IDB quotes and those offered to customers. This, in the end should reduce the probability that simultaneous public orders are executed at significantly different prices from each other.

3.3 Two transparency issues

Although there are likely to be many issues related to transparency that can be examined across equity and GS markets, we constrain the following discussion to two issues. This first examines the potential effect that greater IDB quote and order flow transparency has on dealership markets, while the second examines the effect of greater pre-trade quote transparency.

What effect does the greater degree of transparency have on dealership markets? In order to illustrate the effects of various levels of transparency, we consider two GS markets that differ in their degree of IDB transparency. Public customers in the American GS market benefit from a much higher degree of transparency than is available in most other countries' GS markets (see footnote 20) due to the GovPX information service. Specifically, customers in the US GS market are able to observe inter-dealer broker prices and (order) flows, while those in Canada for example, have little or no access to inter-dealer quote and order flow information.[21] Market participants and many academic researchers[22] often suggest that a lack of pre-trade quote transparency restrains the participation of *active* investors in the market in question. More specifically, it has been suggested in the Canadian GS market that a greater level of pre-trade transparency would cause the current set of Canadian GS customers to more actively manage their portfolios (i.e. reduce their tendency to be buy-and-hold customers) and, more generally, attract new investors to this market. This increased customer activity would not only increase liquidity on its own, but could in turn help shift the dealers' inventory control management risk back onto their customer base, reducing their market making costs, and in turn increasing their ability to provide liquidity. A similar idea is put forward by Lyons (1996). He shows that the level of customer activity is linked to the level of market-wide order flow transparency. Specifically, Lyons, in modelling the trading structure of the FX market, shows that customers do not transact in the second period of a two-period model when inter-dealer order flow information is not available, thus not providing the dealer with beneficial (inventory) risk sharing services. His model shows that dealers endogenously prefer a level of transparency that is greater than zero but less than fully transparent.

The lack of transparency in the Canadian GS market also has an effect on the dealer bid-ask quotations due to the fact that customers will usually "shop around" for the best price by contacting several dealers.[23] This shopping around necessarily informs a series of dealers of the eminent order flow, reducing the specific dealer's ability to pass on, through the inter-dealer sphere, the inventory risks engendered by taking on this large order. As such, the dealers who quote to the customer, being uncertain as to how many dealers this particular customer has already contacted, may widen the quote they offer the customer in order to offset the inventory risk arising because (part of) the dealer market is aware of the pending (large) trade. Hence, if the dealer could be certain that he was the only dealer contacted by the customer, the dealer would quote narrower spreads and be willing to take the other side of a (large) order, because the inventory (price) risks faced by the dealer are necessarily reduced. These arguments parallel those put forward in defence of delayed trade reporting for large orders on the London Stock Exchange, discussed in O'Hara (1995, p. 258-259) and Board and Sutcliffe (1995). However, in this case, an increase in (pre-trade) transparency, is advocated by the market-makers

---

[21] However, the CanPX display system, which is modelled in part after GovPX system, began operations in Canada in late 1998.

[22] See Flood et al. (1997) for example.

[23] Many institutional investors must, for compliance reasons, gather quotations from at least three market-makers before proceeding with a trade.

rather than a delay in reporting (reduced post-trade transparency), as is the case at the LSE. The added transparency eliminates the customer's need to "shop around" the large order in the search for the best price, since the best price across the IDB system is publicly available. This reduces the (inventory) risks market-makers face, thus improving the price or spread the market-makers are willing to offer to customers. In turn, liquidity faced by customers (in terms of bid-ask spread and depth) should, ceteris paribus, improve.

It is also argued (see Perraudin and Vitale (1996) and Lyons (1996) for the FX market) that transparency in the IDB (or inter-dealer market more generally) may increase the speed with which information is in incorporated into market prices. This occurs as market-makers try to extract information from informative IDB trading. This seems to occur in GS markets where anecdotal evidence indicates that dealers will engage in price experimentation to extract information from IDB trades (we expand in this subject in Section 4.3 below).

4. Some remaining questions and future research directions

In this section we discuss various issues related to a partial list of remaining questions that have not received much attention in the microstructural literature. These are highly relevant to increasing our understanding of the factors affecting market liquidity and price discovery in dealership markets. For example, there is much greater variability of order flow in terms of the size of transactions observed by GS market-makers than by those in the equity market. (One should note, however, that GS dealers tend to get orders that are on average much larger than those received by equity dealers.) Order size variability raises issues in the context of upstairs versus downstairs equity markets and the suitability of order driven markets versus quote driven market in enhancing customer welfare.

4.1 Inter-dealer trading in various dealership markets

One aspect of dealership markets' microstructural characteristics that has been largely ignored in the theoretical literature, at least until recently, is the existence of inter-dealer markets that operate in parallel to the customer or public market. In particular, little research has taken place examining the microstructure of these inter-dealer markets in which dealers have a choice of trading bilaterally with other market-makers or trading in an inter-dealer broker market which resembles a screen based "order-driven" auction agency market. Although recent work by Viswanathan and Wang (1998a) show that, if given the choice, risk averse customers would prefer a dealership market over an order-driven market when their variability in order size is significant and when the number of market-makers is large. What drives the market-makers to again (re)trade in the inter-dealer market after receiving a customer order is not well understood.[24] (We return to this question in the following subsection.) Moreover, the related question, "what drives the market-makers' choice of trading bilaterally or via inter-dealer brokers," has attracted even less attention.

A broader question, of importance to assets markets more generally, is why does the scale of inter-dealer trading vary across different dealership markets. The table illustrates the scale of inter-dealer trading across various GS markets as well as that for the FX market and LSE. It shows that although there is some consistency in the proportion of inter-dealer trading carried out across markets, the exception being the dollar/mark FX market, there is some variation in the usage of IDBs by dealers across different dealership markets. Why do dealers in markets like the GS markets, tend to rely almost exclusively on inter-dealer brokers when conducting trading amongst themselves while dealers in the FX markets or the LSE trade bilaterally to a greater extent? Lyons (1996) touches upon the subject in suggesting that IDBs play a role in the information extraction process for FX dealers. As

[24] Note also, that work by Viswanathan and Wang (1998b) has shown that *customer* welfare is improved with the existence of inter-dealer trading.

mentioned in the previous section, Lyons posits that dealers endeavour to ascertain market-wide order flow information by observing the order flow passing through all IDB systems. In a decentralised market this information is vital since it signals information market-makers gathered from public orders or from other private sources.[25] However, this is unable to answer the question of why dealers choose to use IDBs to *execute* inter-dealer trades over bilateral inter-dealer transactions nor the question why we observe proportionally more IDB trading in GS markets versus equity dealership markets.[26] (We touch upon this in the next subsection.) Does the scale of inter-dealing trading or IDB trading have an affect on the liquidity offered by dealers to customers (in terms of bid-ask spread, depth or volume)? How does a decentralised multi-dealer market arrive at an endogenous level of IDB usage? All of these questions are integral to the liquidity of most GS markets, since inter-dealer trading has an impact on the dealer's ability to provide liquidity to customers.

4.2 Differences in order flow dynamics

Another unanswered question is what role do IDBs play in inventory risk sharing among dealers? Recent empirical work by Hansch et al (1998) present empirical evidence that sheds some light on this question for the market-makers on the LSE. They show that inter-dealer trading facilitates the dealer's inventory risk management process. This allows them to take on large inventory positions that they would otherwise be unwilling to take if they could only rebalance positions through the arrival of offsetting public orders. Specifically they show that dealers are more likely to engage in inter-dealer trading when their inventories are high or when they hold extreme, relative inventories.[27] We conjecture further that an important factor affecting the endogenous proportion of inter-dealer and, to a greater extent, IDB trading in dealership markets is the arrival rate of customer orders and the variation in size and direction of these orders. Risk averse dealers who are subjected to greater order arrival variability and/or order size variability will likely require a greater amount of inventory rebalancing/management services. As Ho and Stoll (1983) show, inter-dealer trading will occur as dealers choose between the uncertainty of a public trade arrival and the certainty of inter-dealer trading. That is, when customer to dealer trading intensity is low, risk averse dealers are not likely to witness a rebalancing order from the public sphere and will thus tend to rebalance in the inter-dealer market.[28] Moreover, dealers are more likely to require the anonymous trading offered by inter-dealer brokers (rather than direct "name-give-up" inter-dealer trading) if the order's size is large enough to move markets. One possible explanation for the greater use of inter-dealer brokers in GS securities markets relative to other markets (see table), is that GS market-makers receive orders that are, relative to their desired (risk adjusted) inventory level, on average larger as well as less frequent than their counterparts in the equity. Both Proudman (1995) and Vitale (1998) note that the UK gilt market is characterised by large and infrequent order flow versus that observed in the UK equity market.[29] Second, public orders are more likely to arrive in bunches for GS, since trading volumes jump

---

[25] Vitale (1998) confirms this hypothesis for the UK gilt market where he shows that the total quantity of inter-dealer trading has a significant positive impact on the individual market-maker's transacted price.

[26] We know of only one example of research investigating the dealer's motivation in choosing an inter-dealer trading mechanism, Saporta (1997). Many of the issues discussed in Section 4 are examined by Saporta using a theoretical 3-stage model. Although Saporta does examine the relationship between asset price volatility and the dealer's choice of inter-dealer trading venue, she does not examine the relationship between inter-dealer trading and order flow dynamics.

[27] Reiss and Werner (1998) report similar results.

[28] Vitale (1998) presents data for the UK gilt market indicating trading activity is much lower than that found in most equity markets with the average daily number of trades less than 30.

[29] Viswanathan and Wang (1998a) show that under certain market structures, dealership markets with inter-dealer trading are preferred by customers when their order flows are large. Viswanathan and Wang (1998b) show that dealership markets improve customer welfare, when their order flow is large. They also explain that when order flow can be separated into small and large order flows, customers prefer to trade in hybrid markets where small orders are routed to an order-driven market and large orders to a dealership (or "upstairs") market.

immediately after macroeconomic releases. Although there are news events that may cause similar jumps in trading volumes for certain stocks, most firms now release material information after the close of the exchange trading hours, allowing for a more balanced order flow at the start of the following trading day. This would imply that GS market-makers would tend to have a greater need for inventory rebalancing given their greater susceptibility to news driven, one-way public order flow (which is driven by uninformed, public liquidity traders). Third, equity market dealers also engage in preferencing arrangements (or have vertically integrated operations) which reduces the variance in their (public) order arrival rates. Therefore the difference in order flow dynamics observed by dealers in dealership equity markets versus those in GS markets, may be one explanation for the important difference that exists between these markets in terms of their inter-dealer trading structures.

What is driving the difference in order flow dynamics between GS and equity markets? Institutional investors form the majority of the customer base in GS market while this is much less the case in equity dealership markets in which individual investors participate actively. Institutional investors, such as pension funds, mutual funds and insurance companies, are more sophisticated allowing them to better infer the effect of macroeconomic news on GS prices. This puts them at an advantage over individual investors when negotiating and/or trading with sophisticated market-makers (who, in general, have a dedicated research wing investigating the relation between macroeconomic variables and bond prices). Given the fact that these institutional investors pool individual investor demands for GS, their transaction will be on average large and, since this type of customer is predominate in the GS sphere of customers, the order flow observed by GS market-makers will be relatively large on average and less frequent.

4.3 Differences in inventory risk management practices

In the previous section we argued that inter-dealer trading activity may in part be driven by the public order flow dynamics observed by dealers and that differences in inter-dealer trading activity and structure across dealership equity and GS markets may be the result of differences in public order flow characteristics in these markets. In this section we discuss why differences in the way market-makers manage their inventory positions are also likely to exist across GS and equity markets. The ability of market-makers to take on large public orders (thus offering liquidity) is in part dependent on the way they manage their inventory positions. As discussed above the inter-dealer market provides an outlet for dealers to share inventory risks with other dealers. However, the intensity with which dealers manage their inventory imbalances varies across markets. Hansch et al (1998) notes that mean reversion in LSE market-makers' inventories is stronger than mean reversion in the NYSE specialists' inventories (2.5 days versus 7.3 days for the specialists), while Lyons (1995) indicates that a large Dollar/Mark FX dealer's mean reversion is even greater (with an inventory half-life of 10 minutes). Anecdotal evidence gathered from the Government of Canada (GoC) securities market would seem to indicate that mean reversion is much weaker for GS markets than observed in equity and FX markets. In particular, GS market-makers do not seem to manage inventories as intensely as FX market-makers (e.g. bond traders don't "go home flat" at the end of the day as do FX dealers). In contrast, GS market-makers tend to hold significant inventories over weeks and the desired level of these inventories seems to change over time.[30]

Related to this issue is the observation that risk-averse GS market-makers need not adjust their quoted spreads (reflecting inventory-control effects) as aggressively as equity market-makers, since their inventory can be hedged against price movements (using futures contracts or a mix of offsetting GS

[30] Several reasons were offered by market-makers for why their desired/optimal inventory level changed over time. GoC securities are auctioned to dealers on a regular basis, thus causing the inventory levels to fluctuate as dealers at first take on the securities at auction and then distribute these via secondary market trading. Second, GoC market-makers noted that they often intertwine their market making activities with some minor amount of speculative position taking. This position taking is described as minor since it is separate from the dealer's proprietary trading desk which performs the brunt of any GS speculative activity.

securities).[31] Some evidence in support of this observation is found in Vitale(1998). In contrast to the results in Hansch et al (1998), showing inventory effects on LSE market-makers' transaction prices, Vitale (1998) shows that imbalances in inventories do not influence UK gilt market-maker transaction prices and suggests that this is due to the availability of several hedging avenues for GS market-makers.[32]

Taken together, these observations would seem to imply that GS market-makers can in fact endure a greater divergence of inventories (or more extreme inventory levels) and, given the lower inventory rebalancing needs, are less likely to engage in inter-dealer trading. This contradicts the data in the table showing that GS market-makers in fact do a slightly greater proportion of inter-dealer trading than LSE market-makers. We conjecture that in order for GS market-makers to competitively supply liquidity to the public sphere, that they must *both* be able to endure greater inventory imbalances *and* engage in inter-dealer trading. To be more precise, even though GS market-makers require, relatively to equity market-makers, more extreme inventories before engaging in inter-dealer trading, they nonetheless are relatively active participants in the inter-dealer sphere because GS order flow dynamics are such that these extreme inventory imbalances are frequent occurrences.

Another explanation for the relatively high level of inter-dealer trading observed in GS markets is that the dealers' inter-dealer trading is motivated by information extraction. By trading in the inter-dealer market, dealers are able to garner a sense of the depth of the market at a given price. This is particularly the case for dealers using IDBs where it has been suggested that dealers engage in price experimentation in order to extract payoff relevant information from other dealers.[33]

A testable implication of this conjecture is that the level of activity observed in the inter-dealer market bears some relation to the characteristics of the public order flow in the market. A second avenue of future research would investigate relationships that exist between inter-dealer quote activity and the transparency regime in the dealership market (since changes in transparency cause changes in the amount and distribution of information available to market participants). Some related research has already taken place investigating the relationship between inter-dealer trading activity and transparency [see Scalia and Vacca (1999)].

---

31 Moreover, GS market-makers do not in general have referencing arrangements and as such must compete strictly on a quote basis for customer market share. This also tends to reduce the bid shading since dealers are loath to risk their share of the market-wide order flow out of fear of losing their ability to extract information from this flow.

32 Note that Vitale's results are based on the assumption that desired inventory levels do not vary over time.

33 Anecdotal evidence indicates that dealers will sometimes post a firm quote (for a small amount) on an IDB system in order to see how quickly this quote is "hit" by other dealers. In doing so the dealer posting the quote gets a sense of the depth underlying these quotes, a sense of the direction and magnitude of the public order flow observed by the other dealers, and/or can extract other information that other dealers may possess.

Table

Government securities market microstructure characteristics

Country	Percentage total trading volume that is inter-dealer trading	Percentage of total inter-dealer trading via inter-dealer brokers
US Treasury (1997)	50	95[1]
Government of Canada (1998: Q2)	47	85[2]
Japan (1997)[3]	60	60
UK (1997)	47	98[4]
Other security types		
FX[5]	80	50
LSE[6]	40	40–60

[1] Fleming and Remolona (1999) indicate that over 90% of inter-dealer trading is via IDB while Dattels (1995) indicates IDB trading is near 99% in the US Treasury market. [2] IDB trading has grown in Canada over the years. For example in 1991, IDB trades accounted for 50% of inter-dealer trading. Even in 1997, IDB trading only accounted for 75%. [3] Approximation based on total fixed-income trading, of which, government securities trading account for 95%. Source: Miyanoya et al. (1997). [4] Dattels (1995) indicates that IDB trading accounts for 96% of inter-dealer trading while a recent BIS-CGFS survey indicates that it accounts for 100%. [5] US dollar German Mark FX trading. Source: Lyons (1999). [6] Actually, it is more precise to state that the range for the share of inter-dealer trading as 24-53%. Hansch et al. (1997) indicate that it is 53% and Reiss and Werner (1998) state that the LSE estimates inter-dealer trading to be 30-50% of total LSE trading volume, while they themselves estimate that it is in fact 25-27% for their sample period. The discrepancy has to do with the fact that they control for double counting. They also provide data on the proportion of IDB trading in the LSE inter-dealer market. Vogler (1997) notes that based on 1994 data that inter-dealer trading is 40% of the total trading.

References

Amihud, Y and H Mendelson (1986): "Asset Pricing and the Bid-Ask Spread." *Journal of Financial Economics*, 17: 223-249.

Board, J and C Sutcliffe (1995): "The Effects of Trade Transparency in the London Stock Exchange." Report commissioned by the LSE.

Cao, H and R Lyons (1998): "Inventory Information." Working Paper, Haas School of Business, U.C. Berkeley, August.

Copeland, T and D Galai (1983): "Information effects and the bid-ask spread." *Journal of Finance*, 38: 1457-1469.

Dattels, P (1995): "The Microstructure of Government Securities Markets." IMF Working Paper 95/117.

Fleming, M and E Remolona (1999): "Price Formation and Liquidity in the US Treasury Market: the response to public information." *Journal of Finance*, 54(4), forthcoming.

Flood, M, R Huisman, K Keodijk, R Mahieu and A Röell (1997): "Post-Trade Transparency in Multiple-Dealer Financial Markets." typescript, Maastricht University.

Flood, M, R Huisman, K Keodijk, R Mahieu and A Röell (1999): "Quote Disclosure and Price Discovery in Multiple-Dealer Financial Markets." *The Review of Financial Studies*, Volume 12 (1): 37-59.

Foster, D and S Viswanathan (1993): "Variations in Trading Volume, Return Volatility, and Trading Costs: Evidence on recent price formation models." *Journal of Finance*, 48: 187-211.

Gravelle, T (1999): "Liquidity of the Government of Canada Securities Market: Stylised Facts and Some Market Microstructure Comparisons to the United States Treasury Market." Paper prepared for BIS Committee on the Global Financial System Study Group on Market Liquidity.

Glosten, L and P Milgrom (1985): "Bid, Ask, and Transaction Prices in a Specialist Market with Heterogeneously Informed Agents." *Journal of Financial Economics*, 14: 71-100.

Hansch, O, N Naik and S Viswanathan (1998): "Do Inventories Matter in Dealership Markets? Evidence from the London Stock Exchange." *Journal of Finance*, 53(5): 1623-1656.

Harris, L (1993): "Consolidation, Fragmentation, Segmentation and Regulation." *Financial Institutions and Instruments*, Volume 2(5): 1-28.

Ho, T and H Stoll (1983): "The Dynamics of Dealer Markets Under Competition." *Journal of Finance*, 38(4): 1053-1074.

Kyle, A (1985): "Continuous Auctions and Insider Trading." *Econometrica* 53: 1315-1335.

Leach, J and A Madhavan (1993): "Price experimentation and security market structure." *Review of Financial Studies*, 6: 375-404.

Lyons, R (1995): "Tests of Microstructure Hypotheses in the Foreign Exchange Market." *Journal of Financial Economics*, Volume 39: 321-351.

Lyons, R (1996): "Optimal Transparency in a Dealer Market with an Application to Foreign Exchange." *Journal of Financial Intermediation*, 5: 225-254.

Lyons, R (1999). *The Microstructure Approach to Exchange Rates*, MIT Press, forthcoming.

Madhavan, A and S Smidt (1991): "A Bayesian Model of Intraday Specialist Pricing." *Journal of Financial Economics*, 30: 99-134.

Madhavan, A and S Smidt (1993): "An Analysis of Changes in Specialist Inventories and Quotations." *Journal of Finance*, 48: 1595-1628.

Miyanoya, J, H Inoue and H Higo (1997): "Market Liquidity of the Japanese Government Securities Market." Bank of Japan Working Paper.

Naik, N, A Neuberger and S Viswanathan (1998): "Non-Anonymous Trading and Trade Disclosure Regulation in Competitive Dealership Markets." Working paper, London Business School, February.

O'Hara, M and G Oldfield (1986): "The Microeconomics of Market Making." *Journal of Financial and Quantitative Analysis*, 21: 361-376.

O'Hara, M (1995): *Market Microstructure Theory*, Blackwell Publishers Inc., Cambridge MA.

Pagano, M and Röell (1996): "Transparency and Liquidity: A Comparison of Auction and Dealer Markets with Informed Trading." *Journal of Finance*, Volume 51: 579-611.

Perraudin, W and P Vitale (1996): "Inter-dealer Trade and Information Flows in Decentralized Foreign Exchange Market." in Jeffrey Frankel et al. eds. *The Microstructure of Foreign Exchange Markets*, University of Chicago Press, Chicago, pp. 73-106.

Porter, D and D G Weaver (1998): "Post-Trade Transparency on NASDAQ's National Market System." *Journal of Financial Economics*, Volume 50: 231-252.

Proudman, J (1995): "The Microstructure of the UK gilt market." Bank of England Working Paper 38.

Reiss, P and I M Werner (1998): "Does Risk Sharing Motivate Inter-dealer Trading?" *Journal of Finance*, 53(5): 1657-1703.

Scalia, A and V Vacca (1999): "Market Transparency, Liquidity and Price Discovery: A Case Study." Paper prepared for BIS Committee on the Global Financial System Study Group on Market Liquidity.

Singleton, K (1995): "Institutional and Regulatory Influences on Price Discovery in Cash and Futures Bond Markets." *The Industrial Organization and Regulation of the Securities Industry* (NBER Conference Report), Ed. by A Lo, University of Chicago Press, Chicago, Illinois.

Saporta, V (1997): "Which Inter-Dealer Market Prevails? An Analysis of Inter-Dealer Trading in Opaque Markets." Bank of England Working Paper 59.

Vitale, P (1998): "Two Months in the Life of Several Gilt-Edged Market Makers on the London Stock Exchange." *Journal of International Financial Markets, Institutions & Money*, 8: 301-326.

Viswanathan, S and J J D Wang (1998a): "Market Architecture: Limit-order Books versus Dealership Markets." Mimeo.

Viswanathan, S and J J D Wang (1998b): "Why Is Inter-dealer Trading so Pervasive in Financial Markets?" Mimeo.

Vogler, K (1997): "Risk Allocation and Inter-dealer Trading." European Economic Review, 41: 417-441.