Liquidity of the government of Canada securities market: stylised facts and some market microstructure comparisons to the United States treasury market

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Abstract

The aim of this paper is to study how liquidity in the Government of Canada (GoC) securities market has evolved over time and to determine what factors tend to influence the level of liquidity in the GoC securities market, especially in comparison with the US Treasury market. The principal structural differences between the Canadian and US markets are: the extent of fragmentation in the GoC securities market is higher; activities in the interest rate futures market in Canada is significantly lower; transparency for customers in Canada is lower; and market makers in Canada are subject to a much smaller and less heterogeneous customer base. Using data for the GoC securities market, it is shown that the outstanding amount of securities has a negative effect on bid-ask spreads and a positive effect on turnover ratio. This supports the hypothesis that an increase in effective supply enhances market liquidity. Interest rate volatility has a positive effect on bid-ask spreads and on trading volume in the futures market. This supports the hypothesis that an increase in inventory risk of market makers leads to wider bid-ask spreads in the cash market and higher activities in the futures market for hedging purposes. Other possible factors which have improved liquidity of the GoC securities market in recent years include a decrease of concentration in secondary markets, increases in inter-dealer broker trades and non-resident participation.

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1. Introduction and motivation

In this study we examine the liquidity of the Government of Canada (GoC) securities market. In most countries, the government securities (GS) market is often viewed as the most important financial market, since GS perform several key functions that tend to enhance a country's economic well being. The GS market is of particular interest to central banks since it is often the market in which they perform their domestic monetary operations, where they extract information on future movements of interest rates and where governments raise funds, the latter of interest to central banks with fiscal agency responsibilities. Furthermore, because of their virtually riskless nature, GS function as the pricing benchmark for several other fixed-income securities and serve as collateral (or as part of regulatory capital requirements) for various financial intermediaries, enabling them to finance their operations. More generally, since fixed-income markets possess most of the structural and institutional characteristics as GS markets, a greater understanding of how GS markets function provides central banks with a better understanding of fixed-income markets. Clearly, the liquidity of GS markets should be important to authorities interested in maintaining or enhancing the functioning of these markets and financial markets in general.

There are three distinct channels through which market liquidity has an impact on a central bank's core activities. First, market liquidity will have an impact on monetary policy formulation and implementation activities. Central banks are keenly interested in extracting information from financial asset, since their prices reveal information on current and future monetary conditions, which can be used in the formulation and implementation of monetary policy. However, market liquidity affects how information gets embedded in prices (i.e. it affects the price discovery process). Thus, to the extent that varying levels of market liquidity may impinge on the market's ability to aggregate individual investor information into prices (i.e. market efficiency),[1] it effects the central bank's confidence in its expectational measures. Moreover, the transmission of monetary policy actions to longer maturity fixed-income instruments may be impinged by low levels of market liquidity. Market liquidity also has a more direct impact on monetary policy implementation in that it may affect the efficacy of a central bank's open-market operations.

Second, under certain circumstances, market illiquidity is often a symptom, if not a cause, of systemic financial crises or disruptions. Depending on the level of market liquidity, stressful shocks to financial markets may be amplified rather than dampened. This amplification coupled, in some cases, with the presence of "feedback trading", can lead to liquidity or solvency problems at key financial intermediaries, which, if held unchecked, could lead to payment system disruptions and/or a collapse in credit allocation.[2] Therefore, fluctuations in market liquidity may have direct impact on a central bank's activities both as a lender of last resort and in its supervision (or monitoring) of (prudential) financial stability. Further, in calculating the potential market risks, VaR models ignore liquidation or liquidity risks, defined as the risk of being unable to liquidate a position in a timely manner at a reasonable price. Specifically, the VAR methodology assumes that prices vary in a continuous manner, ignoring the possibility that price movements may be discontinuous (or "gap") in an environment where liquidation risks are prominent. Since risk management systems at most financial intermediaries are now based on the VaR methodology, this shortcoming may cause or aggravate market disruptions.[3]

Third, in its role as fiscal agent, a central bank will share the government's desire to minimise debt service costs. Secondary market liquidity tends to make it easier for governments to issue large amounts of debt at relatively low costs since investors feel more confident in their ability to purchase

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1 Markets are termed *efficient* when prices in these markets reflect all information available to market participants. Muranaga and Shimizu (1997) discuss how changes in market liquidity affect the price discovery process and market efficiency.

2 Muranaga and Shimizu (1997) have a nice discussion of how changes in market liquidity affect market stability.

3 See Muranaga and Ohsawa (1997) for a broader discussion of liquidation or liquidity risks and risk models.

the product in the primary market and subsequently trade the product in a liquid secondary market. In carrying out its role as fiscal agent, therefore, a central bank would work in conjunction with the government to enhance the integrity and efficiency of the government securities market.

In this study, a liquid market is defined as one in which trading is immediate, and where large trades have little impact on current and subsequent prices or bid-ask spreads. Thus *market liquidity*, which is distinct from the monetary or aggregate liquidity more familiar to central bankers trained in macroeconomics, can be defined over four dimensions: Immediacy, depth, width (bid-ask spread), and resiliency. Immediacy refers to the speed with which a trade of a given size at a given cost is completed. Depth refers to the maximal size of a trade for any given bid-ask spread. Width refers to the costs of providing liquidity. Resiliency refers to how quickly prices revert to original (or "fundamental") levels after a large transaction. However, in the context of government securities markets, liquidity is better thought of in terms of the cost of supplying immediacy. Since most GS markets are multi-dealer markets, all trades are as immediate as the time it takes to agree to trade with a dealer.[4] That is, market makers are providers of immediacy. The costs of this immediate trade will vary depending on the size and direction of the trade and on variations in the market makers' costs to providing this immediacy. This in turn implies that liquidity will vary. As this discussion makes clear, the various dimensions of liquidity interact with each other (e.g. for a given (immediate) trade, width will generally increase with size or, for given bid-ask spread, all transaction under a given size can be executed (immediately) without price or spread movement).

This study will focus on how liquidity in the GoC securities market has evolved over time and on determining what factors tend to influence the level of liquidity in the GoC securities market. With the use of trading volume and bid-ask data as well as a series of stylised facts, we are able to examine how liquidity in the GoC securities market has changed over time. In order to sharpen our analysis of which structural or institutional factors have a significant influence on GoC market liquidity, we proceed by drawing comparisons to a GS market that is similar in many dimension to that of the GoC securities market. By doing so, we reduce the dimensionality of our problem. That is, one can think of this study as trying to implement a controlled experiment in which one controls for all but one (or a few) of the factors that may have an impact on the results. Thus, by comparing two GS markets that are structurally very similar, but with differing levels of liquidity, we can control the number of factors that differ across markets and that potentially have an impact on liquidity. Since they have many structural characteristics in common, comparisons are made between the GoC securities market and the market for U.S. Treasuries.

The study will focus on how variations in four microstructural characteristics, specific to GS markets, impact the level of liquidity in GS markets. These factors are: Debt instrument characteristics, competition and concentration, inventory management (or inventory control costs), and transparency or information considerations. In particular, we focus on these four structural characteristics in order to understand how the evolution of liquidity is influenced by changes in these structural factors over time and how differences in these structural factors may cause market liquidity to differ across countries.

The term *debt instrument characteristics* is used to identify a series of factors – specific to government fixed-income instruments – that tend to affect a debt instrument's intrinsic tradeability (such as, the factors affecting its (effective) supply and demand, its distribution among market participants, how it is initially issued, and its fungibility to name a few). Since liquidity in over-the-counter GS markets is, in essence, supplied by dealers, it is important to understand what influences their incentives to make markets and supply immediacy.[5] Therefore the other three factors influence the market maker's ability

[4] In contrast to most equity markets, investors (customers) in GS markets do not place *limit orders* – standing offers to trade at a given price – with dealers, they only place *market orders* with dealers, orders that are immediately executed against a dealers quote. Thus, from the investor's perspective, all trades are immediate.

[5] Throughout this study the term dealer is often used in place of market maker. In reality, not all GS dealers can be considered market makers. However, in this study dealers, unless specified otherwise, are assumed to refer to market makers.

or costs to provide liquidity. *Competition and concentration* is a term used to encompass factors related to the number of competing dealers, the level of dealer competition in the GS market, the manner in which dealers strategically interact or compete, and the size and diversity of the customer base. *Inventory management* include factors affecting the market maker's ability to provide immediacy such as, the costs associated with hedging or re-balancing their positions. Finally *transparency and information* refers to the factors pertaining to the transparency of the trading environment (such as the publication of transaction prices/quantities and real-time quotations) and the interaction of public information and private information, where public information includes macroeconomic news releases and private (or strategic) information includes such things as a dealer's superior knowledge of their own order flow and inventories.

Throughout this study, we endeavour to relate our findings and descriptions of the stylised facts to the ideas developed in market microstructure literature.[6] The next section provides a comparisons of the market structures for the U.S. and Canadian GS markets. Section 3 presents a series of stylised facts describing the evolution of GoC securities market liquidity. Section 4 presents some more formal tests of certain market liquidity hypotheses, while Section 5 briefly summarises our findings and provides additional remarks on how the observed stylised facts my have influenced GS market liquidity in Canada.

2. Market structure

In this section, we provide a review of the institutional structure for the Government of Canada securities market. Generally, the structure of the Canadian market is quite similar to the U.S. Treasury market in that trading in both markets takes place in a continuous, over-the-counter competitive multi-dealer market.[7] Since details on the structure of the U.S. and Canadian market are readily available from various sources,[8] the first part of this section will only provides a summary table reviewing the market structures that are common to both government securities markets. The second part highlights the important institutional/structural differences that exist in both markets.

2.1 Similarities

The market structures that are common to both government securities markets are identified in Table 1 below, where the first column identifies the common component and the second and third column identify the slight discrepancies that are assumed to have negligible effects on market liquidity.

6 See O'Hara (1995) for a primer on the market microstructure literature.

7 See Dattels (1995) for more details on the various types of continuous market structures.

8 See Inoue (1999) for institutional details of the Canadian and US markets, Fleming and Remolona (1997), Sundaresan (1997), Singleton (1995) and Stigum (1990) for details of the U.S. Treasury market only, while we refer you to Harvey and Boisvert (1998), Bank of Canada Review (1996), Branion (1995) and Fettig (1994) for some details on the GoC securities market.

Table 1

Common market structures

Common	**Canada**[1]	**US**[2]
	Primary market	
Primary Dealer (PD) System[3]		
Securities distributed at auctions (with an active pre-auction when issued market)	• Only PDs can submit bids[4] • Top 10 PDs win 75% of auction proceeds (1998 data) • Only index-linked bonds use single-price auctions; all other use competitive bid format.	• Greater number of dealers other than PDs can submit bids • PDs accounted for 72% of auction winnings; top 10 PD accounted for 50% of that • All fixed coupon instruments use single-price auctions
PDs in both countries have similar offsetting obligations and incentives	• Two tier system	
Similar minimum capital requirements for PD status (with commercial banks satisfying Basel Capital Accord)	• Must be IDA registered dealers	• Must be SEC registered dealers
	Secondary market	
OTC multiple dealer, quote driven market: customers must contact dealers for quotes and carry out transaction. Dealers can trade via customer market or interdealer market		• Securities listed on NYSE, but volume negligible
Primary dealers account for majority of turnover • Interdealer trading is either conducted directly or via a "blind" interdealer broker system • A little over 50% of PD trading is with customers	27 PDs; approx. 170 investment dealers;[5] 5 interdealer brokers (IDBs)	32 PDs; 1,700 broker/dealers; 6 IDBs
Repo and Strip trading active		
Book-entry clearing and settlement system similar	Settlement: T+2 shorter maturities; T+3 longer maturities	Settlement: T+1
Tax and accounting systems very similar		

[1] Not that since the study was written, the primary dealer structure in Canada has changed. Please see the Bank of Canada web page (www.bank-banque-canada.ca) for details on the rules of participation in primary market. [2] Most of these stylised facts paper in Flaming and Remolona (1997). [3] See Goldstein and Folkerts-Landau (1994) for details of a primary dealer system.). [4] Under the new primary dealer structure in Canada, customers may submit bids via PDS. [5] Source: Investment Dealers Association (IDA) of Canada.

2.2 Differences

In this section we outline the more substantial differences in market structure that exists between the GoC and U.S. GS markets. This section provides a "snap-shot" of the GoC securities market structure rather than description of how it has evolved over time. As mentioned in the introduction, we concentrate on the structural differences that pertain to the four broad factors that are believed to have a direct impact on market liquidity for OTC government security markets. Note that little effort is made, in this section, to examine how the differing GS market structures impact market liquidity. Rather the structural differences are simply stated here, while their effects on liquidity are examine further in Sections 4 and 5.

2.2.1 Size of markets

The most obvious difference between the U.S. Treasury and Government of Canada securities markets is their size. Table 2 presents the trading volume and amount outstanding of marketable government securities in each country. It is clear that the amount outstanding and volume of transactions (turnover) in Canada is significantly smaller than in the U.S. Indeed, the stock of marketable securities in the U.S. is 12 times that of Canada's while trading volume in the U.S. is 14 times greater than it is in Canada.

In terms of turnover, the Canadian government securities market is vastly inferior to that of the U.S. market. On the other hand, so is Canada's stock of government securities outstanding. Although aggregate turnover data is often used as a rough measure for the liquidity of a GS market, this measure is likely influenced to a certain extent by the size of the market itself and thus should be normalised in some way. A normalised measure of aggregate turnover, that attempts to controls for the size of the market, is the turnover ratio, defined as turnover divided by the stock outstanding.[9] The turnover ratio for each country is presented in Table 2. It is clear that when using this normalised measure of turnover, the apparent differences in trading activity (or the size of the markets) are greatly reduced, with Canada's turnover ratio slightly less than that of the U.S.

Table 2

Size statistics for U.S. and Canadian government securities markets*

(USD billions)

Data	Canada	U.S.
Stock Outstanding	290.5	3,456.8
Turnover Volume	5,552.9	75,901.0
Turnover Ratio	19.1	21.9

***** Source: BoJ/BIS market liquidity study based on 1997 data. An exchange rate US$1.43 CAD was used to convert into US dollars.

Before moving on to describe the other microstructural differences that exist between both countries, one should note that differences in the size of the markets themselves may unavoidably be a factor generating differences in liquidity and that differences in the microstructural factors may only have, relative to the size differences, second order effects on liquidity. Alternatively, the difference in market size may be the underlying cause of the structural or institutional differences that exists across countries. The smaller size of the customer base for GoC securities is certainly reliant on the size of

[9] It is not clear, however, whether or not the turnover ratio defined in this study can be used to compare liquidity across countries. We discuss this in more detail in Section 3. Note that other studies have attempted to control for the size effects by normalising by GDP figures.

the GoC securities market. Thus it may be argued that by comparing the GoC securities market to the U.S. Treasury market, we are not controlling for (eliminating) the most important structural factor affecting liquidity and that we would be better off making comparisons with a GS market of similar size but with perhaps more divergent microstructures.[10] In order to mitigate this criticism, we attempt to control for the size difference between the markets by normalising by the stock of outstanding GS where appropriate. Moreover, our examination of the changes in liquidity over time is not based on the cross-country differences and thus stands on its own.

2.2.2 Debt instrument characteristics: issuance patterns, fragmentation and effective supply

One of the structural differences between the two markets is bond issuing practices. First, the U.S. Treasury market issuance practice can be described as "regularised". That is, since the mid-70's there has been a regular issuance of bonds with a limited set of maturities in relatively large size.[11] Moreover, the maturity of new issues matches, in general, the original maturity of retiring issues. In Canada, however, it was not until 1992, that the GoC bond market took on a "regularised" pattern.[12] Until that time, GoC bond issuances in terms of timing, size and maturity was influenced by market preferences and conditions.[13] As well, some existing bond issues that had a coupon rate close to yields prevailing in its maturity class were sometimes reopened, but a good number of issues were not reopened, many of which became small, illiquid, "orphaned" issues. This resulted in a highly fragmented stock of bonds. Remnants of this practice are still apparent in the current stock of bonds. For example, as of the end of 1997 there were 31 fixed- coupon bonds currently still outstanding that were issued with an original maturity outside the current key maturity classes of 2, 5, 10, and 30 years. These issues had original terms to maturities that ranged between 19- and 25-years. Of these, 19 issues have an amount outstanding less then US$1 billion (CAD) and none are greater than US$3 billion (CAD), which is a fraction of the current benchmark sizes of US$7 to 10 billion (CAD).

Gravelle (1998) argues that though dealer markets are better suited than auction-agency markets to handle multiple security market making, a (too) high degree of fragmentation does eventually have a negative impact a dealer's market making capabilities. When market makers hold a large number of instruments in their inventory, this increases their financing requirements, adds to their (costly) inventory control activities (including hedging activities), and consequently hinders their ability to provide liquidity.

Table 3 presents some statistics on the fixed-coupon instruments for the two countries. Though the U.S. stock of fixed-coupon debt outstanding is about 13 times larger than that of Canada's, it has only 2.7 times the number of issues outstanding, indicating that Canada has a proportionally much larger number of issues outstanding. Moreover, assuming that the issuance practices and the amount outstanding of fixed-coupon debt remains constant over time in Canada, the steady state number of bond issues outstanding would total 34, which is more than half the number issues outstanding at the

[10] The U.K. GS market, has a slightly larger stock of outstanding marketable government securities and has trading volume which is in the same range as the GoC securities market, thus would be a better size controlled comparator. The only country that comes close to the U.S. GS market in terms of outstanding stock of securities is the Japanese GS market.

[11] Three-year Treasury notes were recently dropped from the set of maturities issued. The Treasury over the years has also discontinued the issuance of 7-year notes in 1993, 4-year notes in 1991, and 20-year bonds in 1986.

[12] See Branion (1995) for some further details on the change in issuance practices commencing in 1992.

[13] Also, the continued issuance of some bonds through syndication (until 1992), in which a higher commission was paid on issues with longer terms to maturity, tended to skew the issuance process towards longer maturity bonds. Moreover, this caused the stock of bonds outstanding to have irregular original maturities.

end of 1997. The *average issue size,* defined as the outstanding stock divided by the number of issues, tends to capture these facts and thus provides a rough measure of debt stock fragmentation.[14]

Table 3

Debt stock statistics for U.S. and Canadian bond markets

(USD billions)

	Canada	**US**[1]
Fixed-coupon stock outstanding	204.6	2,693.4
Number of issues	77	206
Average issue size	2.6	13.1
Average benchmark or on-the-run issue size	6.4[2]	15.6

[1] Source: BoJ/ECSC market liquidity study based on 1997 data. Excludes index-linked and zero coupon instruments. [2] Excludes no-longer issued 3-year maturity.

However, as previously mentioned, in 1992 the Government of Canada adopted several initiatives that have basically brought its issuance practices in line with that of the U.S. Treasury. These initiatives included a commitment to large *benchmark* issues, a regular and transparent issuance calendar for 2, 5, 10, and 30 year bonds, and common coupon payment dates. Over the years, the target sizes of these benchmark issues have been increased with the aim of improving issue liquidity. The current benchmark sizes range between US$5 and US$7 billion (US$7-10 billion CAD).[15] The recent initiation of large bond benchmarks explains, in part, why the average issue size is approximately 2/5 the size of the current benchmark in Canada while in the U.S., it is a little more than 4/5 that of the current on-the-runs. This is due to the fact that the average issue size is also a weighted average of current and past issues sizes. Therefore, these ratios not only provide an indication of how fragmented the Canadian market is versus the U.S., they also provide an indication of how gradual the increase in the on-the-run issue size has been in the U.S. relative to the increase in GoC bond issue size.

Though the bond issuance practices for GoC securities have adopted most of the characteristics of the U.S. Treasury's bond issuance practices (i.e. the regular issuance of large benchmark securities), there remains one aspect of the GoC primary market that differs. The large GoC bond sizes are achieved via successive, regular reopenings after the initial auction, whereas the U.S. Treasury issues *new* large benchmarks at almost every auction.[16,17] This implies that a GoC bond does not achieve its so-called

[14] The average issue size for other countries is also available. Inoue (1999) provides data on average issue size that includes index-linked, zero- and fixed-coupon securities. These are US$5.5, US$8.2, US$5.6 and US$14.3 billion (USD) for Italy, Japan, UK, and U.S. government securities markets respectively.

[15] The targeted size of the 10-year and 30-year benchmark issues increased from US$5-6, US$6-8, US$6--9, to US$7-10 billion in 1992, 1993, 1994 and 1996 respectively. Similarly, the target size of the 5-year benchmark bond issue rose from US$4-5, US$5-7, US$6-9, to US$7-10 billion in those same years, while the target size of the 2-year bond went from US$3, US$4, US$4-6, to US$7-10 billion.

[16] In the end, the number of reopenings is conditional on the number of reopening required to achieve the annually announced target size, on whether or not the issue is not too far outside its "key" maturity class and on the size of the individual auctions which are in turn dependent on the total amount of stock being issued within the (budgetary) year. Throughout most of the period since 1992, this has implied that 2-year bonds are reopened once after the initial offering, 5 and 10-year bonds are reopened 3 times and 30-year bonds or reopened 3 to 5 times. Note that the 2, 5, and 10-year bonds are auctioned quarterly (implying a new 2-year every six months and new 5- and 10-years every year) while the 30-year bond is, as of 1998, auctioned semi-annually.

[17] The U.S. Treasury has, at times, chosen to reopen certain fixed-coupon issues (notably 10-year notes).

on-the-run liquidity status, as the most liquid security in its maturity class, until its accumulated size nears that of the old benchmark (usually on its second-to-last or last reopening). This also implies that the transfer of the on-the-run liquidity status (and the liquidity premium attached to the security's price) from the old to the new benchmark is not usually as discrete for GoC bonds, as it is for U.S. coupon securities.

What effect does the practice of reopening issues have on liquidity? If the transfer of benchmark status and in turn the transfer of the liquidity premium (in terms of price) associated with the benchmark bond is as discrete is it is for the one time issue of new bonds (like U.S. Treasury securities), then this issuance technique likely has little consequence on GS market liquidity. However, if this issuance practice succeeds in creating two bonds in the same maturity class with benchmark status and liquidity for even a short period, this may have a positive impact on market liquidity since this increases the number of actively traded securities. This assumes that the increase in the number of active bonds does not take away from the liquidity of off-the-run bonds (i.e. assumes that liquidity can be concentrated in more than one bond or that it is not a zero sum game across the spectrum of bonds within a maturity class). To our knowledge, there has not been any empirical or theoretical research in this area, thus leaving the effect of this issuance practice on market liquidity unresolved.

The issuance practices of the GoC treasury bills (t-bills) have changed relatively little since the mid-1980s. Until late 1997, t-bills were auctioned weekly with 3, 6, and 12 month maturities, with the 3-month t-bill being the largest of the three maturities to be issued. Since then t-bills have been issued on a bi-weekly frequency. The stock of GoC marketable debt had, until recently, continuously increased allowing for an ever increasing stock of t-bills. However, due to a decision to increase the proportion of the fixed-rate debt to 2/3 of the gross government debt in 1996 and the fact that the Government of Canada has been operating with budgetary surpluses, the stock of t-bills have been in a steady decline since 1996.

2.2.3 Inventory risks and costs: futures markets

Though large issue sizes and regular issuance calendars are institutional factors underpinning aspects of market liquidity we term *debt instrument characteristics*, other important institutional differences between U.S. and Canadian government securities markets fall under what we term *inventory risk management*. Specifically, we focus on the relative state of development of interest rate futures markets across the two countries, since a particularly important consideration in a dealer's cost in making markets are its costs associated with hedging and financing large inventories of government securities.

The repo market also plays an integral role in hedging and financing large inventories of government securities and thus would also affect the market maker's inventory management risks and costs and, in turn, their costs to providing immediacy. However, the sample of data available for the Canadian repo market is relatively short (starting in 1994). (Moreover, a BIS CGFS working group is currently studying repo markets with the results of their research efforts being released sometime in late 1998 or early 1999.) As such, this study will concentrate on examining the interaction between futures market activity and GoC securities market liquidity.

In Canada, there currently exist two actively traded domestic exchange-traded interest rate futures contracts. Both of these are traded on the Montréal Exchange. The cash delivery three-month Canadian Banker's Acceptance Futures (BAX) and the physical delivery ten-year Government of Canada Bond Futures (CGB). Recent average daily volume (number of contracts) figures for these contracts ranged around 31,000 for the BAX and 8,500 for the CGB.[18] Though the BAX and CGB are considered to be successful futures contracts in terms of trading activity by Canadian standards, they

[18] The five-year Government of Canada Bond Futures (CGF) and one-month Canadian Banker's Acceptance Futures (BAR) contracts are recent additions to the futures exchange and rarely average more than a few hundred contracts traded a day. They are therefore not considered, for the purposes of this study, active.

generally fall considerably short of the level of activity of similar contracts traded on Australian, French, Japanese, German, UK, and U.S. exchanges. In comparison to the Canadian daily volume figures, recent figures for the ten-year Treasury notes contract (traded on the CBoT) range from 75,000 to 200,000 contracts traded, while the three-month Eurodollar contract (traded on the CME) has ranged from 550,000 to 800,000 contracts traded. Both of the instrument's characteristics and the way they are traded are similar to the CGB and BAX contracts. In fact, these contracts were modelled off those traded at the CME/CBoT. In absolute terms, the Canadian futures trading activity is about 1/25 the size of comparable U.S. futures activity. Moreover, there is a smaller number of active interest rate futures traded in Canada. In the U.S., there are at least 14 interest rate futures contracts (6 on CME, 8 on CBoT). This greater breath of products in the U.S. (not to mention the other U.S. dollar interest rate futures traded on other exchanges in and outside the U.S.), coupled with the lower trading intensity in Canada, indicates that the development of the interest rate futures market in Canada falls significantly short of the U.S. futures market.

Section 3, below, presents some stylised facts for the evolution of trading activity for both futures contracts in Canada.

2.2.4 Transparency

Public access to real-time quote, price, and trade information or ex-post transaction information is often sparse in most government securities markets, the exception being the U.S. government securities market where real time market transparency is provided by GovPX Inc.[19] Inoue (1999) provides a comparison of the level of transparency provided in a group of G5 countries (including Canada and the U.S.). The data indicates that the level of transparency provided to customers (the public) in Canada lies at the lower end of the spectrum in terms of transparency while the U.S. market lies near the upper end. Specifically, customers in Canada must, in general, directly contact a series dealers to ascertain *firm* best bid and ask quotations. Moreover, historical intraday transaction prices and quantities are not generally available to the public, though indicative quotations from a select number of dealers are available intradaily (to the public) from information vendors (such as Bloomberg, Reuters or Telerate). With GovPX, the customer side of the cash U.S. government securities market is much more transparent. [Note that there are currently efforts under way in Canada to develop a screen-based information system similar to GovPX (tentatively named CanPX).] In the interdealer market, both the Canadian and American markets offer comparable levels of transparency with both markets being served by interdealer broker system which provides dealers with realtime screen-based *firm* quotation and transaction data.

2.2.5 Competition and concentration

Though both the U.S. and Canada have primary dealer systems in which primary dealers tend to also be market makers in the secondary government securities market, the number and size (in terms of capitalisation or operations) of these primary dealers differ substantially across countries. In Canada, 27 primary dealers are, as is the case in the U.S. with 32 primary dealers, on one side of the majority of government securities transaction. In Canada 10 of these primary dealers are involved in over 80% of the secondary market turnover reported by primary dealers. Unfortunately, data on the level of U.S. dealer competition is not available.

The size and diversity of the customer base faced by market makers in a GS market may also play a role in their ability to provide liquidity. Therefore, concentration in the customer base should also be considered when comparing market structures. Anecdotal evidence indicates that although there has been a globalisation of financial markets over the years, the dealers in Canada are subject to a much smaller and less heterogeneous customer base for GoC securities than there exist for U.S. Treasuries.

[19] See Fleming and Remolona (1997) for a description of GovPX data. Note that the Italian GS market is also very transparent (see Inoue (1999) for some details).

Evidence presented in Section 3 indicates that the customer base in Canada has diversified over the 1990s with an increasing proportion of non-residents being included in the customer turnover data. Of the domestic customer base that actively trades their portfolios, it has been suggested by market participants that it is proportionally smaller than the active U.S. customer base and that it is dominated by a handful of large institutions. These large institutions tend to use their market power to force the dealers to aggressively compete for their business. Of the other smaller, relatively active domestic customers, there tends to be less diversity in trading strategies and market views; this is in part due to the small number of constituent players. The U.S. GS market, on the other hand, not only attracts a large international base of customers, due to the depth of this market and the U.S. dollar's role as a reserve currency, it also has, arguably, the largest and must heterogeneous domestic customer base.

3. Secondary market liquidity for GoC securities in the 1990s

In this section we offer some time-series measures for the liquidity of the Government of Canada securities market. An often used measure of market liquidity in GS markets is trading volume (or turnover), which measures the accumulated value of transactions over a fixed period. On the other hand, a measure of market liquidity that has a strong theoretical appeal is one that would more closely approximate trading intensity[20]. Theory predicts that market makers, who provide liquidity by absorbing short-term order imbalances that disappear once the other side of the market emerges, will benefit from a higher level of trading intensity since they will wait a shorter period of time to take advantage of a rebalancing or offsetting order. Therefore, the aggregate turnover ratio, defined as total turnover divided by the stock of securities, tends to do a better job of capturing the level of liquidity prevalent in a market than simple turnover, since it better approximates trading intensity. If turnover increased without a corresponding increase in the total stock of GS, this would imply, in principal, an increase in (aggregate) trading frequency. At the end of the first subsection we discuss some of the limitations of using aggregate turnover ratio data as an approximation for the level of liquidity in GS markets. Optimally, one requires data on the number of transactions as well as the size of the transactions for each individual government security to get more precise measure of trading intensity and liquidity. However, given data availability limitations, we use aggregate turnover ratio data as a proxy for the evolution of market liquidity in Canada under the assumption that the dispersion of trading activity across outstanding GoC securities remains relatively constant over time.

The level of trading intensity is also reflected in the dealers quoted bid-ask spread. Since inventory-control or rebalancing risks diminish as trading intensity increases so too does the inventory-control component of the spread. However, the spread is in many ways a better proxy for liquidity than the (aggregate) turnover ratio measure since the spread reflects not only the trading intensity of the instrument, but other factors such as adverse selection, transparency regimes, an asset's price volatility, dealer competition as well as the other (unobserved) factors influencing market making costs. As such, we also present some evidence on the evolution of market liquidity based on quoted bid-ask spreads which are assumed to better reflect the transaction costs charged by market makers to investors demanding immediacy. Though spread data is available at the daily frequency for GoC t-bills, detailed high frequency data for Government of Canada bonds is not available.

Because there exists a link between the market makers' ability to manage its inventory risks and futures market liquidity, we also present some trading statistics for interest rate futures that trade on the Montréal Exchange.

[20] Amihud and Mendelson (1986) show that in equilibrium, liquidity of an asset is correlated with its trading frequency. Datar et al. (1998) suggest that the turnover rate of an asset, defined as the number (of units) of the asset traded divided by the stock outstanding of this asset, has several advantages over the more commonly used quoted bid-ask spreads proxy, one of which being its direct relation to the trade frequency of the asset.

3.1 Government of Canada secondary market turnover over time

An overview of the evolution of the trading volume over time and across types of GoC market participants is presented in what follows. We will start by discussing the time series properties of total trading volume as reported to the Bank of Canada by primary dealers.[21] Figure 1 presents both the bond and t-bill total weekly trading volume (with the eight-week moving average depicted by the thick line). This figure indicates that the bond trading volume has been trending upward, until approximately the fourth quarter of 1997, where it has since plateaued. The volume of transactions in the treasury bill market had increased from 1990 to early 1996. Since that time, the trading volume for t-bills has declined substantially to levels comparable to that in 1990.[22]

The implication drawn from Figure 1 for the evolution of market liquidity, at least in terms of an indicative measure such as turnover, is that the GoC bond market has since the early 1990s become increasingly more liquid while the t-bill market has seen a continual decline in trading activity since mid 1996, after an extended period of increasing liquidity.

3.1.1 Effective supply conditions

What are some of the factors that have led to this increasing trend in GoC bond turnover and the recent decline treasury bill trading volumes. Gravelle (1998) and Miyanoya et. al. (1997) suggest that one factor affecting the trading activity, and in turn the liquidity, of debt instruments is its effective supply. Effective supply is defined as the supply of the security in the hands of active market participants (which is equal to the total supply less the supply that is in the hands of buy- and-hold market participants).[23] It is argued that as the effective supply of these instruments increases, so should its trading activity. Effective supply, in turn, tends to increase with the amount outstanding of these instruments. Gravelle (1998) suggests that a greater effective supply of individual benchmark bonds produces a positive participation externality on the trading activity of these instruments.[24] This implies that, ceteris paribus, trading activity for these instruments should increase (decrease) more quickly than the rise (fall) in their issue size. We will denote this as the *effective supply hypothesis.*

As mentioned in Section 2.2, the issuing practices in the GoC bond market underwent a restructuring aimed at building up distinct benchmark bond maturities of significant size. This change in regime provides us with a specific event in which to gather evidence concerning the hypothesis that increases in an issue's size has positive effect on turnover. Similarly, on-the-run t-bill issue size has decreased since 1996 as the government moved to issuing a higher proportion of its debt as fixed rate (coupon) debt and as government funding requirements decreased.

Some indication of the effects of increased GS issue size is illustrated in Figures 2 and 3. The top panels of Figures 2 and 3 present the average weekly turnover (averaged over a month) and the amount outstanding (stock) of GoC bonds and t-bills respectively. Figure 2 indicates that the average weekly turnover for bonds has generally trended upward in tandem with the increase in outstanding

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[21] Each of the primary dealers submits a money market and bond market trading report that covers one-week of fixed-income trading. The trading volume is segmented into several categories that include a primary distributors sales and purchases from other investment dealers, interdealer brokers, banks, other domestic market participants (customers), and non-resident market participants. The trading volume is also segmented across trading instruments such as Government of Canada marketable securities, provincial marketable securities, corporate fixed-income instruments and asset-backed securities to name a few.

[22] Note that, currently, the turnover data is available at no higher than the weekly frequency. Also, collection of weekly GoC turnover data began in 1989.

[23] Effective supply may be increased by repo or securities lending transaction where securities are lent out of buy-and-hold portfolios. Symmetrically, effective supply diminishes as GS securities are stripped.

[24] This positive participation externality explanation is similar to the idea that a feedback loop between trading volume and market liquidity explains the fact that trading tends to concentrate at particular times of the day in the Admati and Pfleiderer (1988) study.

stock and benchmark size of GoC bonds. Similarly, Figure 3 indicates that the t-bill turnover tends to be highly correlated with the stock of these instruments. (Although there was no formal policy in place, average on-the-run t-bill issue size did increase as a result of greater government funding needs, before 1996.).[25] The bottom panels present the monthly turnover ratio, defined as the average monthly turnover divided by the stock of the GoC securities, for both the bond and t-bill market. The rise in the bond turnover ratio is an indication that trading volume has increased more than one-for-one with the increase in the size of the outstanding stock of bonds. Thus, the evidence presented in Figure 2 is consistent with the effective supply hypothesis. The same can be said for t-bill trading volume. As the stock of t-bills increased from 1990 to 1995, so too did the turnover ratio (see bottom panel of Figure 3). After 1995, however, the transaction volume for t-bills has decline somewhat more quickly than the stock supporting the hypothesis that there exist a positive issue size externality.

Aggregate turnover ratio caveat

In the above analysis, we used aggregate turnover ratio data under the assumption that these data do a better job of capturing the level of liquidity prevalent in a market than raw turnover data. However, an increase in the aggregate turnover ratio does not necessarily imply that each individual security experienced an increase in trading activity (or trading frequency). It's possible that certain individual securities experienced a reduction in trade frequency, as aggregate trade frequency increased. What does this mean for market-wide liquidity? When there is no decline in trading activity for any individual security, an increase in aggregate turnover translates into an increase in market-wide trading intensity and liquidity. But when certain securities experience a decline in trading activity as other experience an increase in trading frequency, it is not clear whether the market as a whole has become more liquid or whether some individual securities have become more liquid at the expense of others. Without data on the individual securities trading activity, a measure of liquidity at the disaggregated level is not possible. Moreover, the effective supply hypothesis is based on the relation between the issue size and trading activity of *individual* instruments. Therefore, it is not clear that, without the assumption that the dispersion of trading activity across the stock of GS remains relatively constant over time, increases in the turnover ratio reflect increases in trading frequency (and, in turn, market liquidity) arising from the effective supply consequences of larger individual benchmark issue sizes. (In Section 4 we suggest a more powerful method to test the effective supply hypothesis.)

As the preceding discussion makes clear, when using *aggregated* turnover data, one must make assumptions about possible changes in the dispersion of trading activity across the stock of individual securities. It also implies that cross-country comparisons of market liquidity based on aggregate turnover ratio data may be biased since the dispersion of trading activity across the stock of GS invariably differs across countries. For example, two countries with equal aggregate turnover ratios may in fact have significantly different (aggregate) trading intensities, when trading activity (and turnover) in one country is concentrated in a smaller number of instruments relative to the other. Moreover, as noted by Inoue (1999), the effective turnover ratio may be affected by the central bank's or the government's practice of holding till maturity a large proportion of the stock of marketable securities. Given that these practices vary across countries, this implies that the turnover ratios are not directly comparable across countries. However, within a country, under the assumption that the dispersion of trading activity across its stock of GS is constant or relatively persistent, aggregate turnover ratios are likely a good approximation for changes in trading intensity and liquidity (over time), and a useful indicator for effective supply effects.

[25] Since there were no changes in the issuance frequency (until late 1997) of t-bills and since t-bill securities roll-over relatively quickly, an increase in on-the-run issue size would necessarily occur in tandem with an increase in government funding financed with t-bill securities.

3.1.2 Inventory control/rebalancing

Since the GoC market is an OTC dealer market where market makers are the predominate supplier of liquidity, it is important to understand how dealers maintain their desired level of inventory. Do they lay off (acquire) their unwanted (wanted) inventory positions through interdealer brokers or do they trade bilaterally with other dealers or customers? Inventory management via interdealer brokers (IDBs) has very different informational consequences than inventory management that occurs via bilateral transactions. Thus the price formation process will differ between markets with different levels of interdealer broking. An advantage of trading via interdealer brokers is that it gives dealers the ability to rebalance there inventory position quickly. If dealers are continuously hit by customer orders of varying size and direction, the process of rebalancing their inventory positions is shorter via interdealer broking trades than via direct bilateral interdealer trades (or waiting for offsetting customers trades). Thus, in theory, the greater use of interdealer trade should increase the dealers ability to absorb order flow and in turn improve the dealers ability to provide liquidity. However, as the work of Lyons (1996) suggests, the interdealer broker market is also an avenue where dealers extract information on aggregate order flow. Therefore the increasing use of interdealer brokers may reflect an endogenously (or exogenously) driven change in the level of aggregate order flow transparency. This section tries to shed light on the evolution of dealers' position control activities in the GoC market.

The first panel in Table 4 presents the average turnover of primary dealer (PD) trading conducted with various types of counterparties, as a per cent of total PD trading. The percentages are averaged over sub-periods in order to provide a sense of the evolution the market. The bottom panel in Table 4 presents the average percentage of total interdealer trading that occurs through interdealer brokers (IDBs) and the average percentage of non-resident trading as a proportion of total customer trading. Note also the customer figures presented in Panel A include non-resident turnover and thus the percentages add up to a figure that is greater than 100.

Table 4

Proportion of total primary dealer trading by counterparty

	1991-93	1994-96	1997-98
Panel A: Two-way trading (%)			
IDBs	30.6	37.2	39.3
Other dealers directly	15.8	10.2	7.1
Non-residents	15.2	19.7	22.7
Customers	53.7	52.6	53.6
Panel B: Within category trading (%)			
IDB/total interdealer	65.8	78.5	84.7
Non-resident/total customer	28.4	37.5	42.3

Figure 4 displays graphically the data summarised in Panel A of Table 4. As is evident from the table and figure, there is a clear rapid increase in the use of interdealer brokers on the part of primary distributors (the irregular dashed line). Most dealers suggest that the decrease in broker fees over the years is likely the main contributing factor to the increasing use of interdealer brokers. Nonetheless, the increasing use of IDBs does imply an increasing level of anonymous trading taking place among the dealers. Moreover, interdealer broker trades tend to be more numerous and at pre-set sizes than direct interdealer trading or trades with customers. The trade size in the interdealer broker market also varies little over time when compared to the trade size variation observed by dealers when trading bilaterally with customers or other dealers. These two facts imply that even though the decline in broker fees may have been the impetus for the increasing use of IDBs, this increasing use of IDBs by the dealers has, in the end, changed the manner in which they rebalance their inventory positions. That is, the increasing reliance on IDBs implies an explicit change in the dealers' inventory management behaviour. Although, interdealer broker services have been shown to reduce search costs and in the end the costs of transacting in dealership markets [see Garbade (1978) and Flood et a. (1998)], there has been little research into the informational or strategic consequences of allowing dealers to trade among themselves via interdealer brokers versus trading directly in bilateral transactions. Hence, based on the idea that search and transaction costs are reduced (and ignoring informational consequences of IDB trading) the most we can conclude from the increase in IDB trading by dealers is that it may have reduced their costs to making markets.

From Figure 4 one can also discern an increasing trend in the volume of transaction carried out by PDs with non-residents (the dotted line).[26] Panel A of Table 4 indicates that non-resident turnover has increased from 15.2% of total turnover (conducted by PDs) to approximately 22.7% in the last subperiod. Moreover, non-resident turnover went from 28.4% of total customer turnover to 42.3% of total customer turnover. This increasing trend in non-resident trading runs parallel to the increasing prevalence of large foreign institutional clients interested in GoC securities often noted by dealers (in conversations with them). Anecdotal evidence also indicates that the large foreign based GoC dealers tend to do a larger proportion of their customer trades with non-residents than do domestic dealers. Market participants also suggest that this rise in non-resident trading may be caused, in part, by the increasing size of foreign affiliates (of domestic primary dealers), since transactions with affiliates are counted as non-resident trades in our data set. However, assuming that this plays a small role, the growth of non-resident trading is assumed to have had a positive impact on the size and heterogeneity of the customer base (over and above any growth that may have occurred in the domestic customer base for GoC securities).

What does a potential increase in customer base size and heterogeneity imply? An important factor effecting the supply of liquidity in dealer markets, is the ability of market makers to lay off or acquire positions (and hedge their inventory risks) using their account/customer base rather than transacting in the interdealer. In effect, dealers will depend, to a certain extent, on customer transactions as a source for inventory risk management activities. This concept is not new and has recently been modelled by Lyons (1996).[27] The availability of the customer market as a source of position control will depend on the size and heterogeneity of the market maker's customer base [and the transparency of the market as shown by Lyons (1996)]. If the customer base is not very large or its views (investor characteristics) not very diverse, then the market maker's order flows (or the aggregate direction of flows) will likely fluctuate to greater extent than would a market maker's with a large and heterogeneous customer base. Similarly, fluctuations in the *availability* of the customer market for position control services will increase as the size and heterogeneity its customer base decreases[28]. We discuss further the implications of this change in the composition of customer trading on the ability of dealers to manage their positions in Section 5.

3.1.3 Hedging inventory risks: futures markets

Rather than directly increasing or decreasing their inventories by laying off or acquiring securities, dealers can hedge their positions using interest rate futures. This, in turn, tends to ease the dealer's ability to hedge its trades, reduces their bid-ask spread (or increases the size they trade of a given spread) and thus increases liquidity. Second, increased activity in the futures market directly generates

[26] Non-resident transactions (as reported by primary dealers) are defined as direct trades with non-resident individual or institutional clients. Trades with foreign affiliates of the reporting PD are also considered to be in this category. Intrafirm trades with foreign branches are not considered non-resident trades.

[27] Lyons (1996) models how this customer activity enables dealers to shift some of the inventory risk they bear as market makers back onto their customers, if dealership markets are not too transparent.

[28] In other words orders received by a particular dealer is more likely to be distributed symmetrically (normally) around zero the greater the customer base and the greater the base is heterogeneous.

trading volume in the cash market due to arbitrage transactions. Thus, well developed and liquid futures markets tend to enhance the liquidity of the underlying cash GS market. In this subsection, we investigate the evolution of interest rate futures turnover in Canada.

Figures 5 and 6 display the average daily volume (over a month) and month-end open interest for all the BAX and CGB contracts outstanding from January 1990 to September 1998. These figures illustrate that the BAX contract is clearly the more active of the two interest rate futures contracts with open interest and trading volume figures approximately 4 to 6 times greater than the CGB futures (in terms of number of contracts). One of the more interesting features depicted in these figures is the tendency of these futures contracts to reach plateaus in terms of trading activity. For example, both the BAX and CGB volume remained range bound till approximately early-1997, after having increased substantially from 1993 till mid-1994. After sharply increasing over a brief period in early-1997, the volume figures for the CGB contract again remained range bound till August 1998. Therefore, there tends to be some persistence in futures trading activity. That is to say, once an increase in trading activity does occur, for whatever reason, the level of activity does not revert to the low levels that preceded the increase. This is consistent with the hypothesis that high trading activities are self-enforcing or self-sustaining.[29] To elaborate, there is a persistence to the level of trading activity because the higher trading activity attracts market participants that previously found the market too inactive to participant in, which in turn increases trading activity and attracts more market participants and so on.

The growth in trading activity in both the BAX and CGB contracts in 1993-1994 and in the BAX for 1997 tend to coincide with an anticipated increases in interest rates and/or with a rise in interest rate volatility (or uncertainty). Some support for this hypothesis is presented in Figure 7 where the monthly three-month Banker's Acceptances and ten-year bond yields are displayed in the thicker lines while their daily observations are displayed in the thinner lines. Specifically, three-month and ten-year yields increased considerably during 1994 while three-month rates in Canada increased in 1997-1998. Though ten-year yields steadily decreased through most of 1997-1998, this was also a period in which the Asian financial crisis came to the fore, perhaps explaining in part the 1997 rise in CGB activity. As indicated in Figures 5 and 6, the most striking increasing in trading activity for both the CGB and the BAX contracts occurred in August-September 1998. August 1998 is the month that the Canadian currency came under extreme pressure with the BoC raising its policy rate by a 100 basis points, where ten-year yields rose more than 50 basis points after declining for more than a year, and in which the Asian financial crisis took on a more global flavour as Russia devalued its currency. This cursory analysis implies that the increase in futures activity may be linked to an increase in hedging activity by dealers and other market participants due to rising interest rates risks or increases in interest rate volatility. Note also that investors who expect debt instrument prices to decline (or expect interest rates to rise) would find it considerably easier to "go short" in the futures market rather than the underlying cash market due to less onerous margin requirements. However, this discrepancy in speculative trading activity between the futures and cash market is not as pronounced for investors wishing to "go long" based on expectations of declining interest rates. This structural asymmetry in the ease with which a market participant can short an instrument could explain the increase in futures activity during periods of rising (expected) interest rates and is not necessarily related to market participants' hedging activity when faced with increased volatility.[30]

Boisvert and Harvey (1998) also suggest that the recent increase trading activity in BAX futures is in part due to the decline in the supply of treasury bills that has occurred since mid-1996. (Compare the amount of t-bill's outstanding in Figure 3 to BAX open interest levels, Figure 5, during the 1996-1998

[29] Pagano (1989) and Admati and Pfleiderer (1988) considers questions related to this self-sustaining or feedback aspect of market liquidity.

[30] However, a well-developed repo market makes it easier for market participant, dealers in particular, to short the cash instrument. This, in turn, reduces the margin-related asymmetry that exist between the cash and futures market for investors wishing to "go short."

period.) They suggest that investors, interested in taking (speculative) positions in the money market, have increasingly tended to invest in the BAX market rather than the treasury bill market in order to avoid technical problems linked to the t-bills' dwindling supply.

Recent conversation with dealers suggests a third explanation for the 1997-1998 rise in trading activity. They mentioned that the arrival of additional "locals" from Chicago and France in the Montréal trading pits may be in part responsible for the increase in BAX futures activity.[31] Also, it was noted that the sudden increase in CGB activity was due to the arrival foreign investors (such as hedge funds) who participate in futures markets only after the volume of transaction crosses a critical threshold (e.g. 10,000 contracts per day).

3.2 Competition/concentration

Increased market maker competition is generally assumed to enhance market liquidity.[32] Intuitively, market makers will compete with each others for order flow for two reasons. First an increasing number of transaction for a given bid-ask spread will increase market making trading volume and profits and second, the larger the market maker's share of aggregate order flow, the more precise is the market maker's proprietary information on the securities' expected price movements, the greater its proprietary trading profits (which are distinct from its market making profits). However, as is the case in goods markets, the predominate way market makers compete for order flow is by setting the best (lowest) price, which in terms of government securities markets means the best (narrowest) bid-ask spread. And, because narrower bid-ask spreads are generally ***a*** reflection of the costs of immediacy, this implies that increased competition leads to greater liquidity.

Given the above discussion, it is clear that changes in the level of dealer concentration over time may be one of the contributing factors explaining the evolution of GoC securities market liquidity. In Canada, the government securities industry has undergone a series of mergers among *domestic* dealers (and Banks) since 1987. One of the ongoing concerns of the authorities has been the effects of these mergers on the integrity of the secondary market for Canadian government securities. It is believed that a reduction in the number of active market maker dealers has or will eventually cause a reduction in the level of market liquidity.

In the industrial organisation literature there are several measures of market concentration available. In this study we calculate three measures, the 6– and 10-firm concentration ratios and the Herfindahl index. These concentration measures, presented in Table 5, are calculated in terms of each dealer's share of yearly secondary *bond* market turnover from 1993 to the second quarter of 1998.[33,34] These data indicate a declining trend in secondary market concentration during a period where two major mergers, among the top tier of domestic primary dealers, occurred and where four foreign based dealers gained primary dealer status.

Specifically, on September 1994 two primary dealers, that ranked among the top 12 in terms of 1993 secondary bond market turnover, merged, while on September 1996, another merger occurred between two firms that ranked among the top 8 in terms of 1995 secondary bond market turnover. Further,

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[31] Locals in futures markets act in a similar way to market makers.

[32] One should note, however, that it is not necessarily the case that a greater number of market makers leads to greater competition. Dutta and Madhavan (1997) show that collusive (non-competitive) outcomes are possible independent of the number of market makers.

[33] The firm concentration ratios measure the sum of the market share for the top 6 or 10 primary dealers in terms of their secondary market turnover. The Herfindahl index is defined as the sum of the squared market shares of all reporting primary dealers. See Tirole (1988) for details.

[34] Dealer concentration is, perhaps, better measured in terms a dealers share of *customer* turnover, rather than customer plus interdealer turnover, since this would be a cleaner measure of the actual level of competition that exists for customer order flow.

three foreign based dealers gained primary dealer status on November 1995, while another gained PD status on October 1994.[35] Note also that 6 other foreign dealers had attained PD status before 1993. While some of these dealers have subsequently dropped out of the PD ranks, two of these have seen their share of secondary market trading activity increase to the point where they are now rank among the top echelon of primary dealers.

In the top panel of Table 5, the concentration statistics for 1994 and 1996 are calculated assuming that the merged firms remained separate trading entities for the entire year while the bottom panel combines the firms to form one trading entity throughout the year. Because the mergers occurred two-thirds of the way through the year,[36] actual concentration statistics should in reality lie somewhere in between these figures. Thus, by weighting the top and bottom 1994 and 1996 measures by the proportion of the year that the firms reported their trading data as separate entities, we have adjusted the estimates for the concentration statistics to better reflect this fact. These calculations are presented in brackets.[37]

The data indicates that the entree of new dealers or the capture of greater market share by existing foreign based dealers has had a greater impact on concentration measures than the occurrence of two mergers among relatively large PDs during the sample period. These data also support the widely adhered to view that gains in market share arising from mergers in the securities industry are, at best, fleeting. A combined firm's market share is never expected to equal the simple addition of the individual pre-merger market shares of each firm since large clients prefer to spread their business among several firms (in order, among other things, to better hide their trading strategies).

Table 5

Measures of concentration in secondary bond market turnover

Year	6 Firm concentration ratio	10 Firm concentration ratio	Herfindhal index
1993	0.647	0.898	0.0907
1994	**0.627 (0.638)**	**0.886 (0.892)**	**0.0878 (0.0899)**
1995	0.618	0.840	0.0817
1996	**0.614 (0.626)**	**0.798 (0.810)**	**0.0787 (0.0821)**
1997	0.597	0.841	0.0815
1998 Q2	0.607	0.834	0.0817
1994*	**0.660**	**0.905**	**0.0940**
1996*	**0.651**	**0.835**	**0.0889**

3.3 Bid-ask spreads over time

One measure of market liquidity often utilised is some measure of bid-ask spreads. As mentioned in the introduction, the bid-ask spread reflects the costs to the dealers in providing immediacy. These costs include, *inventory management costs*, *trading cost*s, and costs associated with trading with a

[35] Note that since dealers have to meet certain trading activity requirements to get accorded PD status, it implies that they had maintained a threshold level of secondary (and primary) market activity over an extended period preceding the date they become PDs. This implies that the PD in question was likely taking away market share from existing PDs before it officially joined the PD ranks.

[36] Note also that, before these firms started reporting the trading volume as one entity, there was likely a period of several weeks for which these firms' trading desks were already behaving cooperatively (or as one trading desk).

[37] Moreover, this declining trend has occurred even as the number of primary bond market distributors/ dealers declined from 48 in January of 1993 to 27 in the second quarter of 1998. Nonetheless, the dealers that lost their PD status generally lost it because their behaviour was not consistent with that of market makers. Specifically, their primary and secondary market trading activity was in fact minuscule in comparison to the remaining PD.

better informed investor (*adverse-selection costs*).[38] Given the discussion in the previous subsection, the spread may also be affected by the level of competition among dealers.

Recent conversations with dealers indicate that benchmark bond spreads through most of the 1990s have averaged 2 cents for the 2-year, 3 to 5 cents for the 5-year, 5 cents for the 10-year and 7-10 cents for the 30-year for every US$100 face value. These are quoted spreads for transaction up to the US$100 million range. (Non-benchmark or off-the-run securities are quoted with somewhat higher spreads.) Unfortunately, high frequency time series bond spread data were not available for this study.

Data at a daily frequency are available for quoted treasury bill spreads. Figure 8 presents the weekly average of daily observations of the 90-day t-bill spreads in terms of yield from January 1990 to October 1998, while Figure 9 adds the 180 and 360-day bid-ask t-bill spreads to the 90-day spreads presented in Figure 8. Of the three maturities, the 90-day t-bill tends to have the narrowest spread, a reflection of its greater amount outstanding, its greater turnover and, thus, its greater liquidity on average. An examination of Figures 7 and 8 highlights the correlation between sudden increases in the 3-month yields and the sudden increase in the bid-ask spreads for 90-day treasury bills. These are apparent in 1992, in the early part of 1995 and again in late 1997 early 1998. There is also a sharp increase in spreads again in September to October of 1998. It is clear that an increase in interest rate volatility or uncertainty has a direct impact on the market makers willingness (or costs) to providing liquidity. As 3-month interest rates increase in a sudden manner, so do the spreads. This increase in the cost of immediacy supplied by market makers is a reflection of the higher inventory risk management costs they face. As interest rate uncertainty/volatility increases, dealers will tend to manage their position more closely or, alternatively, they will reduce their position altogether. This in turn leads to a reduction in their ability to supply immediacy. Second, higher interest rate volatility will tend to reduce the order flow that dealers observe which in turn reduces the dealer's ability to manage their positions. This too has a negative impact on the dealer's costs of supplying immediacy and in turn a positive impact on the bid-ask spreads they quote. In summary, market makers will widen their quoted spreads when faced with increased inventory risks as their inventory-control component of the spread increase. Moreover, it is unlikely that other components of the spread (adverse selection, and trading costs) would vary over such a brief period.

This observed increase in t-bill spreads is not unlike the intraday widening of spreads found in the U.S. Treasury market reported by Fleming and Remolona (1997). Specifically, they find that intraday, spreads will increase in reaction to sharp price changes that arise from the release of new public information. The data we have is at a lower frequency than in the Fleming and Remolona study. This implies that either the period of high price volatility is more persistent than the intraday price movements observed in Fleming and Remolona (i.e. they occur over days rather than over several minutes) or that the spreads' reaction to a relatively short periods (minutes) of price volatility is relatively persistent. A review of the daily 3-month interest rate series (see Figure 7) reveals several periods of large, persistent *inter-day* yield changes (notably late 1992), which is consistent with the former explanation. However, anecdotal evidence suggests that, though spreads widen concurrently with periods of increased yield volatility, and that this volatility is fairly persistent, spreads tend to revert back to their original pre-volatile (average) levels a significant time after the period of yield-volatility has ceased, which is consistent with the latter explanation. This latter observation may be due to a lack of *aggressive* competition among dealers.

Ignoring the large, sudden increase in spreads that occurred in August-September of 1998, one can discern an increasing trend in spreads since early 1996 which may be attributed to the decline in the outstanding supply of t-bills. Symmetrically, there seems to be a decreasing trend at the beginning of the sample, from 1990 to about mid-1994 (ignoring the transitory increased that occurred in late 1992) that is correlated with a rise in the supply of t-bills. Boisvert and Harvey (1998) present some evidence on the spreads negative correlation with the supply of t-bills, which speaks to the idea that increases in

[38] Flood et al. (1998) argue that, aside from inventory-holding costs, order-processing or trading costs, and adverse-selection costs, there is a fourth component to the spread based on search costs.

the effective supply of a security and has a positive affect on its liquidity (see Subsection 3.1). They show that there has been a decline in the volume of transaction accompanying the decline in the supply of t-bills (see Figure 3). In support of their hypothesis that a decreasing supply of t-bills since 1996 has had a negative effect on liquidity, they add further that the when-issued market for t-bills has also become less active indicating that market makers find it riskier to sell t-bills forward (ahead of the auction), while spreads between t-bills and comparable instruments (bankers' acceptances) have widened, reflecting the market participants inelastic demand for t-bills. It's difficult, however, to untangle the effects of the yield volatility on bid-ask spreads from the liquidity effects arising from supply changes by simply examining Figures 3, 7 and 8. In Section 4, we present some empirical evidence on this matter.

4. Some quantitative assessments

In this section we consider, in a slightly more formal setting, the hypothesis that increases in the effective supply has a positive effect on secondary market trading activity for (cash) GoC securities as well as a negative (narrowing) effect on bid-ask spreads and the hypothesis that interest rate volatility or uncertainty has a positive (widening) effect on bid-ask spreads.

4.1 Bid-ask hypotheses

(a) Yield volatility hypothesis

A simple linear regression of the 90-day t-bill spread on squared daily changes in 90-day yields – a rough proxy for yield volatility – plus four lags of the spread, results in a significant positive coefficient being attached to the volatility proxy. The estimated coefficient on the volatility proxy is presented in the first row of Table 6. The result is consistent with the hypothesis that periods of increased price/yield volatility has a positive impact on spreads[39] .

(b) Effective supply hypothesis

We also ran a second separate regression in which the volatility proxy is replaced by the stock of outstanding t-bills. In this case the coefficient for the outstanding stock of t-bills is significant and negative. The estimated coefficient on the t-bill stock is present in second row of Table 6. This is consistent with the hypothesis that an increase in the size of the debt instrument would increase the supply of the security in the hands of active market participants (as opposed to buy-and-hold participants), increasing the effective supply, and thus increasing the security's liquidity, which is reflected in a narrowing of the spread.

Finally, a regression was carried out in which both the volatility proxy and the stock of t-bills are right-hand-side variable. The regression results, presented in Table 6, indicate that both variables are significant at the 5% level.

[39] Note that Ho and Stoll's (1983) model of bid-ask spreads in dealership markets predict that the spread will depend positively on the variance of the asset's return, which is assumed to be a time invariant characteristic of the asset itself. Although these results seem consistent with the prediction of their model, it is not clear whether the Ho and Stoll model can be mapped into a dynamic settings where the price volatility varies over time.

Table 6

Linear regression results for T-bill spreads

Specification	Volatility coefficient	Stock coefficient	Adj.R^2	D-W	Box-pierce
1	2.465e-4* (5.168)		0.389	1.998	23.517
2		-4.31e-6* (-3.906)	0.371	1.954	23.507
3	2.742e-4* (5.838)	-5.09e-6* (-4.742)	0.417	2.006	17.869

Regression based on 456 observations of daily data averaged over a week from January 1990 to October 1998. T-statistics are in parenthesis. D-W indicates the Durbin-Watson statistic and the Box-Pierce Statistics for serial correlation is based on 20 autocorrelations. The 5% critical value for the Box-Pierce statistic is 31.4.

* Indicates that the estimate is significant at the 5% level. The lagged coefficients, though not presented, were statistically significant.

A regression of the spread on the lagged spread variables only, yields an adjusted R^2 measure of 0.354. This is largely a result of the t-bill spread variable's high degree of persistence. However, both the stock of t-bills and the volatility proxy, when added as explanatory variables (row 3), tend to improve the fit of the regression, with the R^2 measure increasing to 0.417. Note that the regressions were carried out with the same variables observed at a daily frequency. The results remained qualitatively the same. Note also that up to 5 lags of the two independent variables were added to the regressions and were found to be insignificant with and without the current (date t) independent variables present.

4.2 Turnover hypothesis

(a) Effective supply hypothesis: bond market

We start by considering the effective supply hypothesis where liquidity is proxied by the bond turnover ratio. A simple linear regression of the bond turnover ratio on an index of the stock of outstanding bonds plus 5 lags of the ratio variable, results in significant positive coefficient for the stock variable. The estimated coefficient and Adj. R^2 are present in the first row of Table 7. This result tends to support the hypothesis that an increase in the size of the benchmark issue increases its liquidity.

(b) Effective supply hypothesis: T-Bill market

The same hypothesis is considered for t-bill turnover. By regressing the t-bill turnover ratio on an index of the stock of t-bills plus 4 lags of the ratio variable we find that the stock coefficient to be significant and positive which is not inconsistent with the hypothesis. The results of the regression are presented in the t-bill row of Table 7.

Table 7

Linear regression results for bond and T-Bill turnover

Dependent variable	Stock coefficient	Adj.R^2	D-W	Box-pierce	Adj.R^2 No stock variable
Bond turnover ratio	0.0396* (2.953)	0.324	1.971	22.443	0.310
T-bill turnover ratio	0.0787* (3.178)	0.650	2.025	19.846	0.643

Bond regression based on 377 observations of weekly data from August 1991 to October 1998. T-bill regression based on 455 observations of weekly data from February 1990 to October 1998. T-statistics are in paranthesis. D-W indicates the Durbin-Watson statistic and the Box-Pierce statistics for serial correlation is based on 20 autocorrelations. The 5% critical value for the Box-Pierce statistic is 31.4.

* Indicates that the estimate is significant at the 5% level. The lagged coefficients, though not presented, were statistically significant.

The results were qualitatively the same when simple turnover was used in place of turnover ratio variable. Note that the regressions are carried out at the weekly frequency. Note also that up to 5 lags of the independent variable were added to the regressions and were found to be insignificant with and without the current independent variable present.

4.3 Hedging hypothesis

In Section 3.1.3, we noted that futures trading activity tended to increase during period of heightened interest rate risks. In this section we consider this ocular observation in a slightly more formal framework. Specifically, we consider the hypothesis that during periods in which dealers (as well as other market participants) anticipate rising interest rate or experience a period of increased interest volatility, they will seek to manage their inventory's exposure to these risk by increasing their hedging activity and in turn their use of futures contracts. Thus, futures activity should be increasing with the level of interest rate risks.

Table 8 presents the regression results investigating the dependence of the daily volume of BAX and CGB contracts on yield volatility, which is calculated as the square of daily changes in the yield for the underlying instrument of the contract. Due to the persistence of the dependent variables, the BAX regression included 10 lags of the BAX volume variable while in the CGB regression 5 lags of the CGB volume were added. The estimated yield volatility coefficient are both significant and positive, thus supporting the observations made in Section 3 and the hypothesis that futures activity increases during periods of heightened interest rate risk.[40]

[40] Note also that up to 10 lags of the independent variable were added to the regressions and were found to be insignificant with and without the current independent variable present.

Table 8

Linear regression results for 3-month and 10-year futures

Dependent variable	Volatility coefficient	Adj. R^2	D-W	Box-pierce	Adj. R^2 No. vol. variables
BAX volume	3.783* (9.112)	0.682	2.082	22.861	0.645
CGB volume	5.083* (5.296)	0.349	1.950	26.285	0.330

BAX regression based on 1028 observations of daily data from January 1994 to October 1998. CGB regression based on 1228 observations of daily data from January 1993 to October 1998. T-statistics are in parenthesis. D-W indicates the Durbin-Watson statistic and the Box-Pierce Statistics for serial correlation is based on 40 autocorrelations. The 5% critical value for the Box-Pierce statistic is 55.8.

* Indicates that the estimate is significant at the 5% level. The lagged coefficients, though not presented, were statistically significant.

4.4 Caveats

Of the previous set of regression results, the bid-ask spread yield volatility regression can be viewed as bearing the strongest evidence in support of a market microstructure hypothesis. Specifically, the tendency for spreads to widen during periods of yield volatility is consistent with the inventory-control models such as Ho and Stoll's (1983) and previous empirical work by Fleming and Remolona (1997). The strength of the results comes from the fact that the other factors assumed to influence the spread (the adverse selection and trading costs components) are unlikely to have varied greatly during these brief periods of yield volatility.[41] That is, trading costs vary slowly over time while little (payoff-relevant) asymmetric information exist in GS markets.[42]

The results presented in Table 8, on the other hand, can not, on their own, provide strong support of the inventory-control hypothesis. Rather they should be viewed jointly with the bid-ask spreads results (row 1 of Table 6), strengthening their support for the inventory-control hypothesis. In isolation, however, the evidence in Table 8 is relatively weak because there is no evidence that (cash) market makers did in fact increase their futures trading activity during these periods of heightened interest rate risks in reaction to increased inventory control needs. That is, the composition of the market participants involved in trading futures contracts is not known. It is equally likely that there simply occurred an increased in speculative (short trades) activity based on an expected rise in interest rates. Without more detailed time series data on the dealers' trading behaviour in the futures market, the results in Section 4.3, at best, indicate that the data are *not inconsistent* with the idea that market makers, facing higher price volatility, engaged in a greater degree of inventory risk management via the futures market.

A similar argument can be made for the effective supply regression results presented in Table 7. The results only indicate that the time series behaviour of GoC securities turnover is not inconsistent with the effective supply hypothesis. As mentioned in Section 3, this is due to the fact that the effective supply notion is related to the liquidity of individual GS and that aggregate turnover ratio data is a noisy proxy for the trading activity of individual securities. A more powerful test of the effective

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41 Also, it is unlikely that the increase in spreads occurred due to a rather sudden drop in the level of competition between dealers, since the level of competition tends to be persistent over time.

42 This also assumes that any asymmetric information that arises due to the market makers private knowledge of its order flow is not likely to persist outside of the trading day. However, this assumption remains one of the more interesting question to be answered in the market microstructure literature.

supply hypothesis would compare the liquidity of a series of different benchmark securities that were identical in all respects except for their amount outstanding (and, perhaps, their coupons). For example, econometric techniques and specifications based on panel data sets could be used to analyse turnover and issue size time series data for a cross-section of benchmark bonds that possessed the same original maturity.[43] Further, this type of empirical investigation would also need to control for other factors, such as the interest rate environment while the issue remained a benchmark, the distribution of the issue across market participants, changes in interdealer trading behaviour, the length of time the bond issue remained a benchmark as well as changes in the behaviour of inter-related markets like the repo or futures markets. A factor of particular interest that we did not control for in the effective supply hypothesis tests (for t-bills), is the frequency of new issues. In September of 1997 t-bill issuance moved from a weekly to a bi-weekly schedule in order to augment the average amount issued at auction. Under the effective supply hypothesis this should have a positive effect on liquidity. However, this factor is not specified in the regression model, which may have biased our estimates.

Note that the results presented in row 2 of Table 6 supporting the effective supply hypothesis provide slightly stronger evidence in favour of this hypothesis than those based on turnover data, since the liquidity proxy used is the bid-ask spread which is a better measure of liquidity than *aggregated* turnover data. (The same may not have been said if more disaggregated turnover data was available.)

Before moving on to the following section, we would like to highlight the tentative nature of the estimation techniques themselves. Specifically, it is well known that a simple linear regression does a poor job of capturing any low frequency dynamics, such as non-stationary or cointegrating dynamics, that are likely embedded in some of the variables used.[44] Moreover, since market liquidity is in essence a market microstructural phenomena, it is likely that data observed at a much higher frequency would allow for a much sharper delineation of the factors affecting liquidity [for an example of this type of study, see Fleming and Remolona (1997) and Scalia and Vacca (1999)]. Moreover, the data utilised may in fact be a poor measure of actual changes in liquidity. For example, *quoted* bid-ask spreads do not represent the actually *firm* bid-ask spreads faced by investors nor do they necessarily reflect actual traded prices.[45] Therefore, these regression results should be viewed simply as initial attempts at examining whether the data available are consistent with the proposed hypotheses. A more formal empirical study, that employs higher frequency data and richer econometric specifications both in terms of the times series econometric models and in terms of empirical microstructural models, lies outside the scope of this study.[46]

5. Summary and concluding comments

Because market liquidity is fundamentally difficult to define let alone measure, it is often difficult to draw conclusion on what affects the level of market liquidity based on one or two proxies for liquidity. Even when detailed, high frequency transaction data is available, it is not always possible to get a precise measure of market liquidity. In light of this, we have attempted, in this study, to assess how liquidity has varied over a long horizon (long horizon in terms of the market microstructure theory) and on a more aggregate or macro scale. We do this for two reasons. First, this type of analysis is driven by the limitations of the data. Second, comparison across countries in the aggregate are easier

[43] See Greene (1993) Chapter 16 for details on these panel data econometric techniques.

[44] The t-bill spread, stock and turnover variables display unit root or near unit root dynamics.

[45] Peterson and Fialkowski (1994) show that quoted bid-ask spreads are a poor measure of actual transaction costs faced by investors.

[46] For a survey of advanced time series econometric techniques see Hamilton (1994) and Greene (1993). Campbell et al. (1997), Hasbrouck (1996), and Engle and Lange (1997) represent a small sample of the literature related to the empirical investigation of market microstructural questions.

to carry out due to this type of data's ready accessibility for most countries. We summarise our findings along two lines of investigation, the factors that affected the evolution of market liquidity over time and the factors that contribute to the differences in liquidity across countries.

5.1 How has liquidity evolved in Canada?

Generally, there are indications that liquidity in the GoC securities market has improved over time. In terms of turnover activity, liquidity has increased over time for most GoC securities, the exception being in the t-bill segment of the GoC securities market, where turnover has declined in tandem with the sharp drop in the supply of this instrument. However, this evidence highlights the role that effective supply has on turnover in fixed-income products such as GS securities. We showed that the turnover ratio tended to increase, both for bonds and t-bills, as the size of the (on-the-run) benchmark GoC securities increased, supporting the hypothesis that liquidity for fixed income instruments were positively related to their issue size. This effective supply effect is also observed when liquidity is measured in terms of bid-ask spreads (in the t-bill market). As the average on-the-run issue size of t-bills increased (decreased), its bid-ask spread tended to decrease (increase) over time. In Canada, liquidity tends diminish in periods of increased interest rate volatility. We found that bid-ask t-bill spreads tended to increase significantly during (persistent) periods of increased interest rate risks.

Liquidity, in terms of trading activity, has improved over the years for both the 10-year bond futures and the 3-month futures. The rise in trading activity has accelerated over the last two years, especially for the 3-month futures contract. This increased liquidity should, in principal, make it easier for dealers (and investors) to manage interest rate risk associated with their cash inventory and in turn reduce their costs associated with providing immediacy/liquidity. However, futures also serve as a venue for investors to speculate on the future course of interest rates. As such, the increased activity in the BAX contract may be the result of market participants shifting their speculative activity out of the t-bill market, as its liquidity decreases due to the dwindling supply of t-bills, into the futures market.

We also examined how microstructure factors, that tend to have an impact on the level of liquidity offered in the market, have changed over time. First, we documented a decrease in concentration among primary dealers in terms of secondary trading market share since 1993. This has likely increased competitive pressures on bid-ask spreads over time, thus improving (or maintaining) the level of market liquidity available to investors. Second we show that primary dealers have increasingly relied on interdealer brokers when conducting transaction with other dealers. The rapid increase in interdealer broker trading, though initiated by a decrease in broker fees, has likely made it easier for dealers to conduct their inventory rebalancing activities and improved modestly the depth of the market, since dealers are now in a better position to take advantage of inventory risk sharing services offered through interdealer trading. Third, we also documented an increase in non-resident participation in the GoC market. By possibly increasing the level of heterogeneity in customer trading strategies, this change in customer composition may have reduced the probability of dealers being subjected to periods of one sided order flow and in turn improved the market's ability to withstand market disruptions. A more formal examination that the changes in these last three factors have on market liquidity has not been considered in this study and is left for future research.

5.2 What factors contribute to the differences in liquidity across countries?

We noted in Section 2 that among dealers, the level of transparency was approximately equal in both countries, but that customers for U.S. Treasuries benefited from a much higher degree of transparency than GoC securities customers due to the availability of the GovPX information service. Specifically, customers in the U.S. GS market are able to observed interdealer brokered prices and (aggregate) order flow, while in Canada, customers have little or no access to interdealer transaction information. Market participants often suggests that this lack of transparency has held back the increase participation of *active* investors in the GoC market. A greater level of transparency, would cause the current set of 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 increase customer activity 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 immediacy. The idea that an increase in customer activity would accompany an increase in the level of market-wide transparency is similar to that proposed in the theoretical work of Lyons (1996).[47]

The lack of transparency in the Canadian GS market also has more direct effect on the dealer bid-ask quotations because of the fact that a customer will usually "shop around" for the best price by contacting several dealers. This shopping around necessarily informs a series of dealers of the eminent order flow. Moreover, the dealers that 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 (and last) 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, page 258-259) and Board and Sutcliffe (1995). However, in this case, an increase in transparency (with the introduction of a GovPX type service), is advocated by the market makers rather than a delay in reporting (reduced transparency), as is the case at the LSE. The added transparency eliminates the customer's need to "shop around" the large order in order to find 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 offered to customers (in terms of bid-ask spread and depth) should, ceteris paribus, improve.

In summary, there are grounds to believe that differing levels of transparency across GS markets has engendered significant differences in market liquidity. As previously mentioned, there are now efforts in Canada to implement an information service similar to GovPX. The implementation of this service may provide researchers with an discrete event with which to test many of the hypotheses that are related to market liquidity and market transparency.

Different issuance practices seem to have also contributed to significant differences in market liquidity across countries. Although the Canadian authorities now favour the regular issuance of a limited number of large benchmark debt instruments, past issuance practices were shown to have left the structure of outstanding stock of bonds in a highly fragmented state, when compared to the structure of the U.S. Treasury fixed-coupon debt. We suggested that the higher degree of bond stock fragmentation has a negative effect on the dealer's market making capacity an thus reduces the level of market liquidity across the sphere of outstanding off-the-run GoC bonds relative Treasury off-the-runs. We also noted that large benchmark bond sizes are achieved by a series of successive reopenings, which contrasts the U.S. practice of issuing new benchmark securities at each auction. However, since this area of market microstructure research remains, to our knowledge, relatively undeveloped, it was not clear what kind of impact the practice of *regularly* reopening bond issues has on the instruments' liquidity.

Although activity in Canadian interest rate futures has grown substantially over the years, we indicated that the activity level remains substantially below exchange traded interest rate futures activity in the U.S. and other countries. In effect, since futures markets generate trading volume in the cash market (due to price arbitrage activity) and since they allow market makers to more easily hedge their cash positions, the lack of well developed futures markets has likely restricted market liquidity, either in terms of bid-ask spread or turnover, in the Canadian GS market verses the U.S. market.

47 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 interdealer 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 transparency regime that is greater than zero but less than fully transparent.

We suggested that the smaller size of the customer base for GoC securities, relative to that for Treasury instruments, likely contributes to the discrepancy in market liquidity across these countries. First, the size of the customer base affects the degree with which dealers are able to manage their inventory risks. Second, any factor that increases number of market participant in the GS market has a self-enforcing or self-sustain effect on market liquidity due to the feedback effects that increasing the customer base has on trading activity [see Pagano (1989)]. Therefore, initiatives aimed at enlarging the customer base are more likely to pay off, in terms of increased market liquidity, than other possible structural or institutional changes initiated by the authorities. We also noted that the authorities should not only pursue initiative that tend to enlarge the customer base for GoC securities, but should also promote customer heterogeneity since a diversity of trading strategies (investment views) tends to promote trading activity. Some examples of ways to attract a larger and/or more diversified pool of customers to trade GoC securities include, greater transparency, increased futures activity with the introduction of cash-delivery bond futures or around-the-clock trading, and (possibly) electronic trading for cash and futures GoC securities. However, the size of the customer base is likely linked, in some way, to the stock of GS, or more generally to the economic size of the country (and, quite likely what role the country's currency has in international transactions).[48] This implies that any differences in liquidity across GS markets may go beyond structural or institutional factors that authorities can manipulate.

[48] Many market participants we interviewed suggested that the level of liquidity achieved in any fixed-income market will ultimately be tied, in some way, to the stock of debt outstanding.

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Figure 1: Total Trading Activity as Reported by Primary Dealers

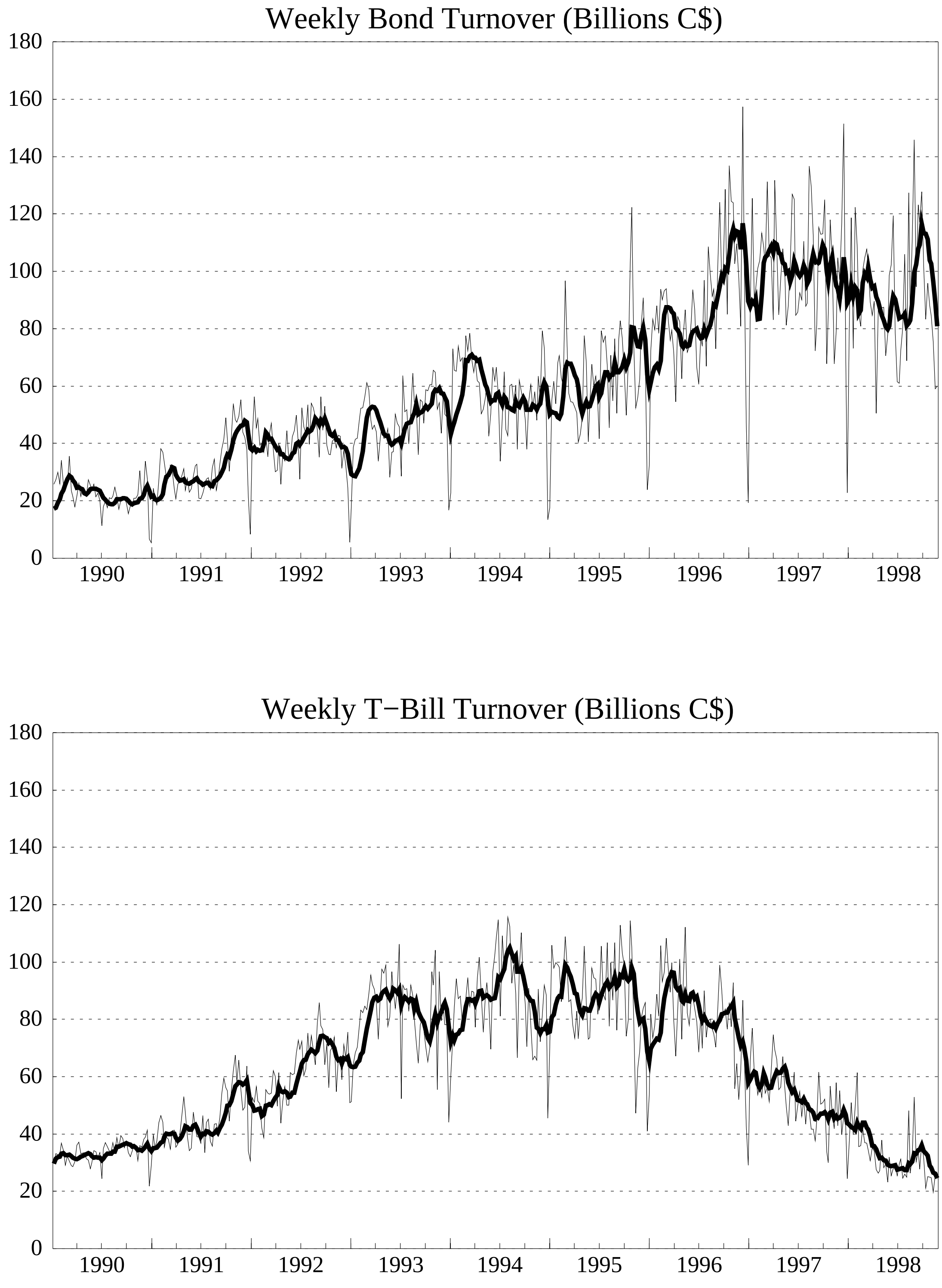
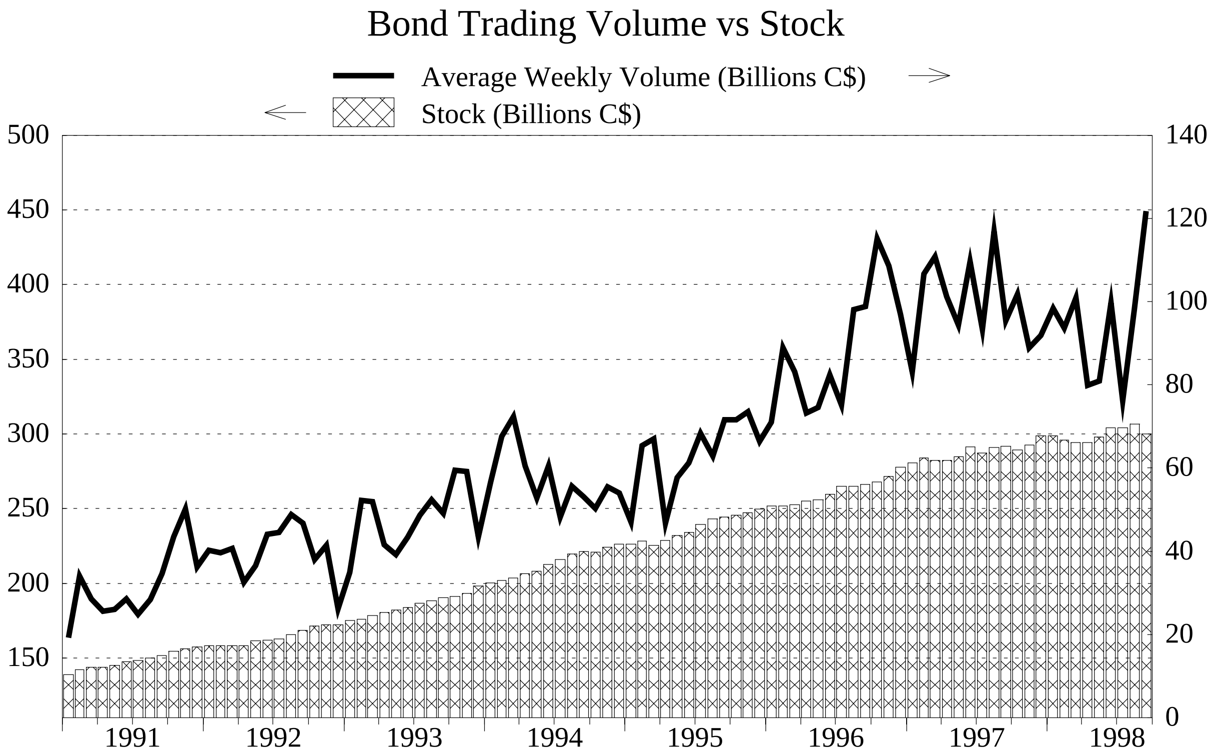


Figure 2: Bond Trading Activity Relative to Stock



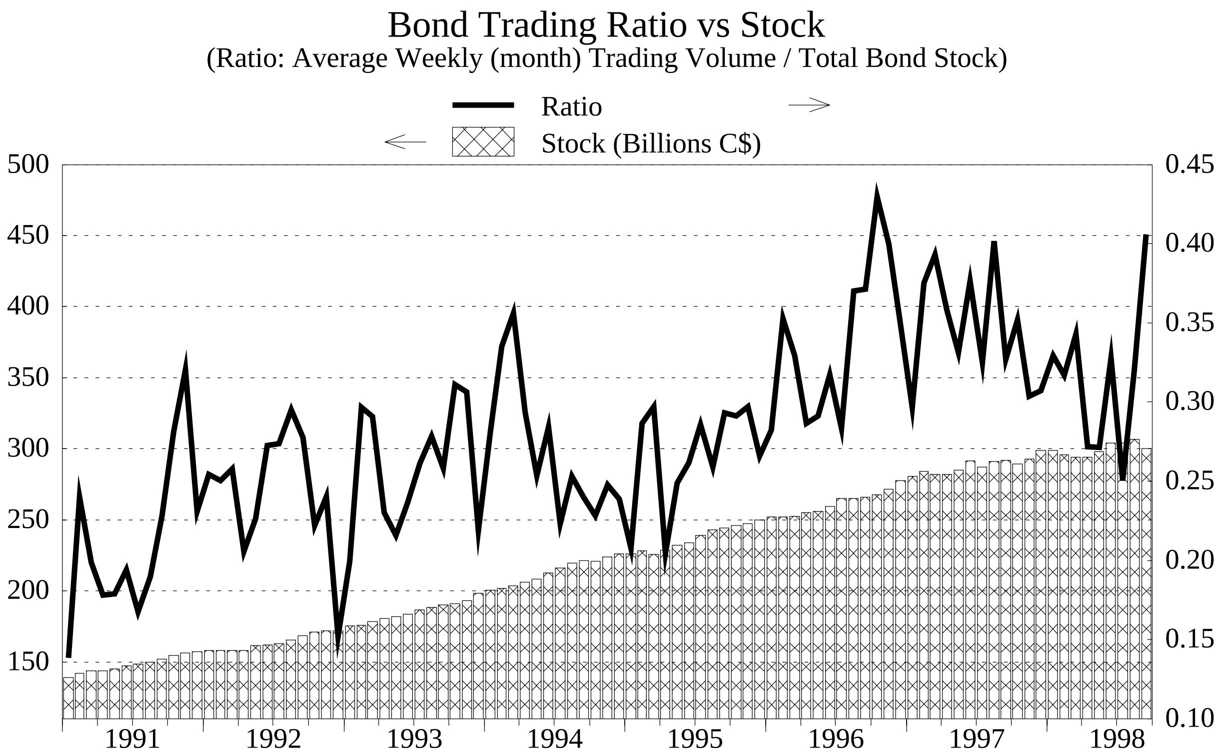
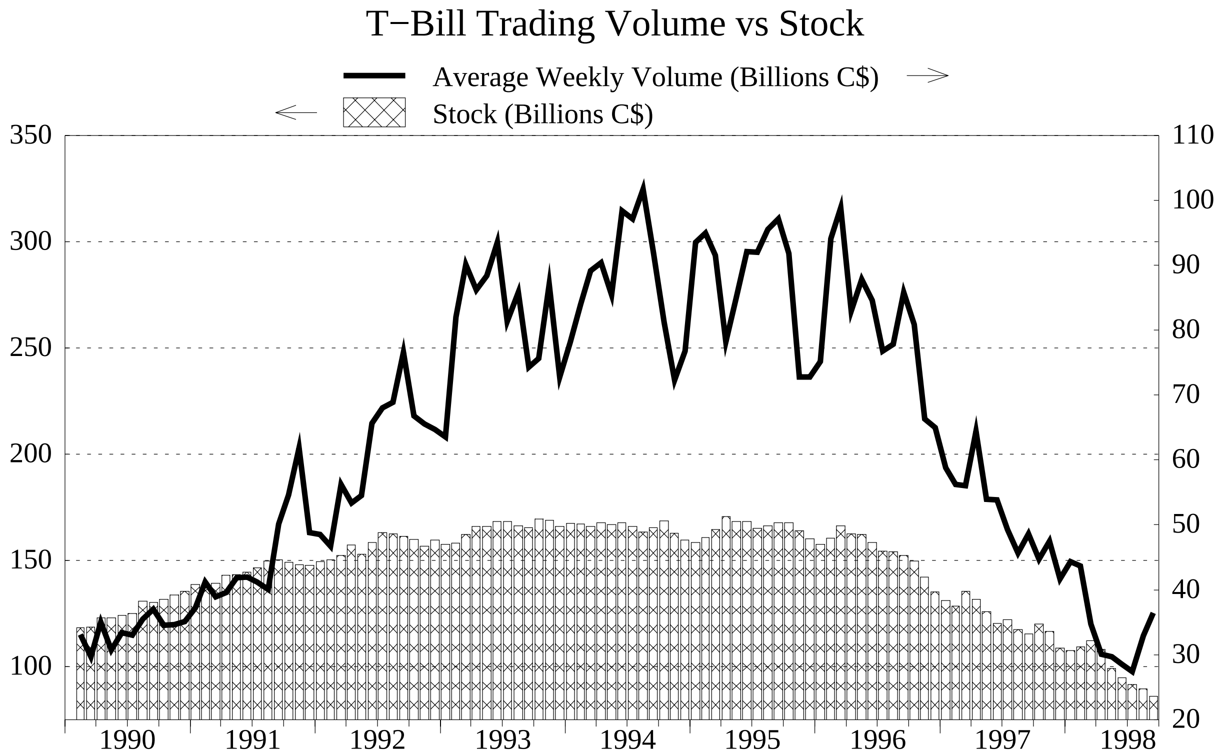


Figure 3: T−Bill Trading Activity Relative to Stock



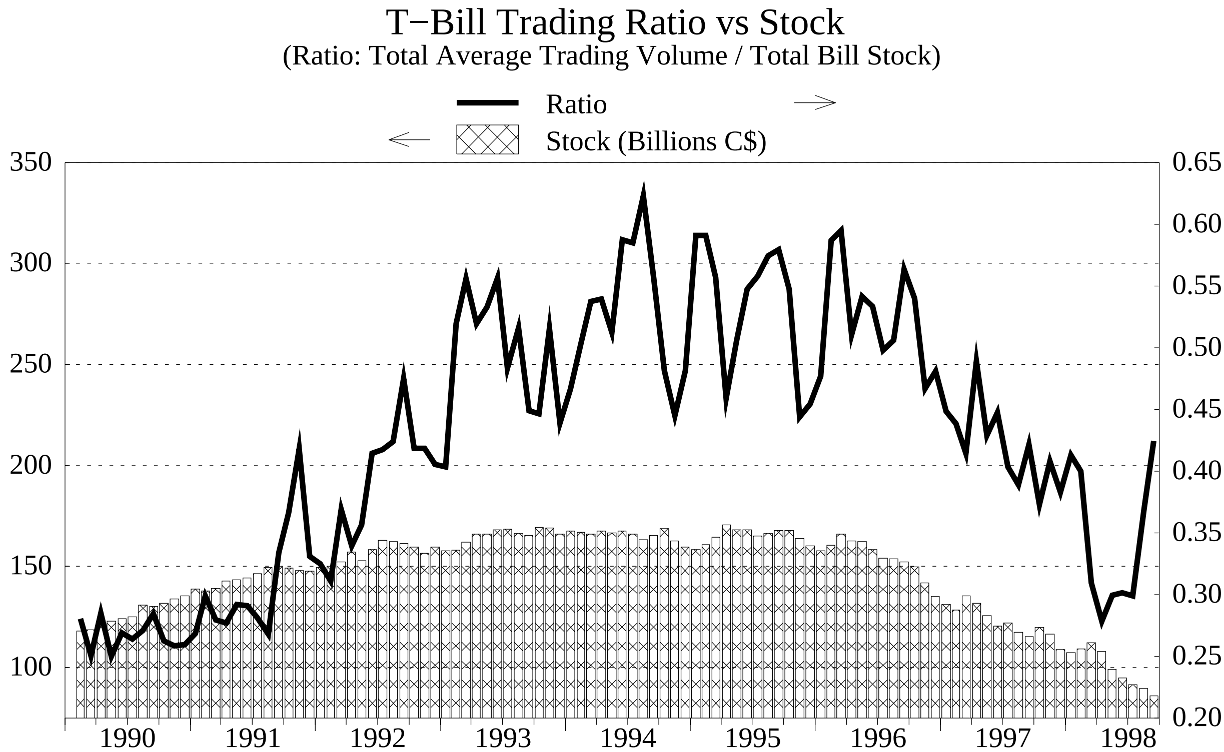


Figure 4: Share of Government of Canada Bond Trading Volume

Volume Divided by Total Volume (%)

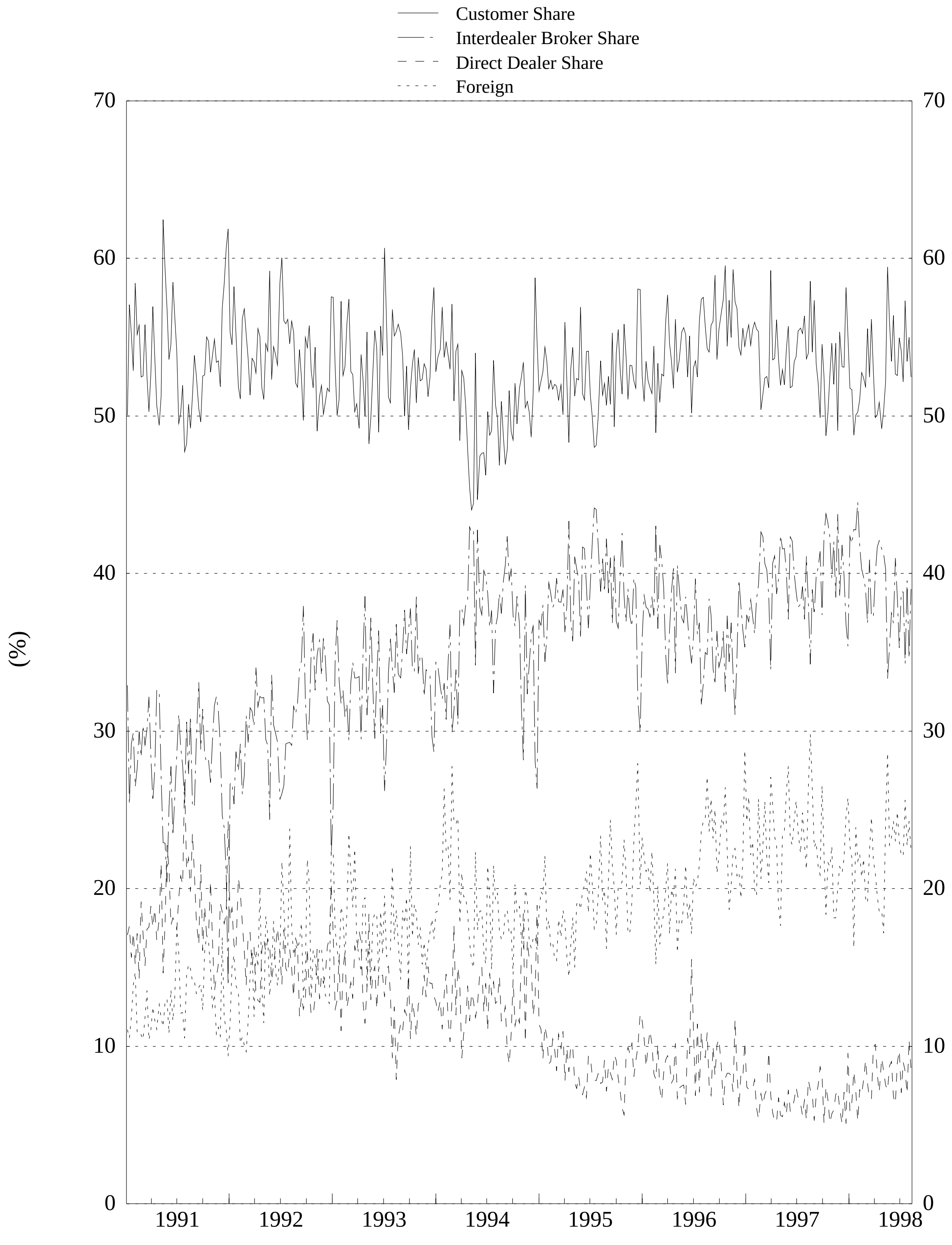
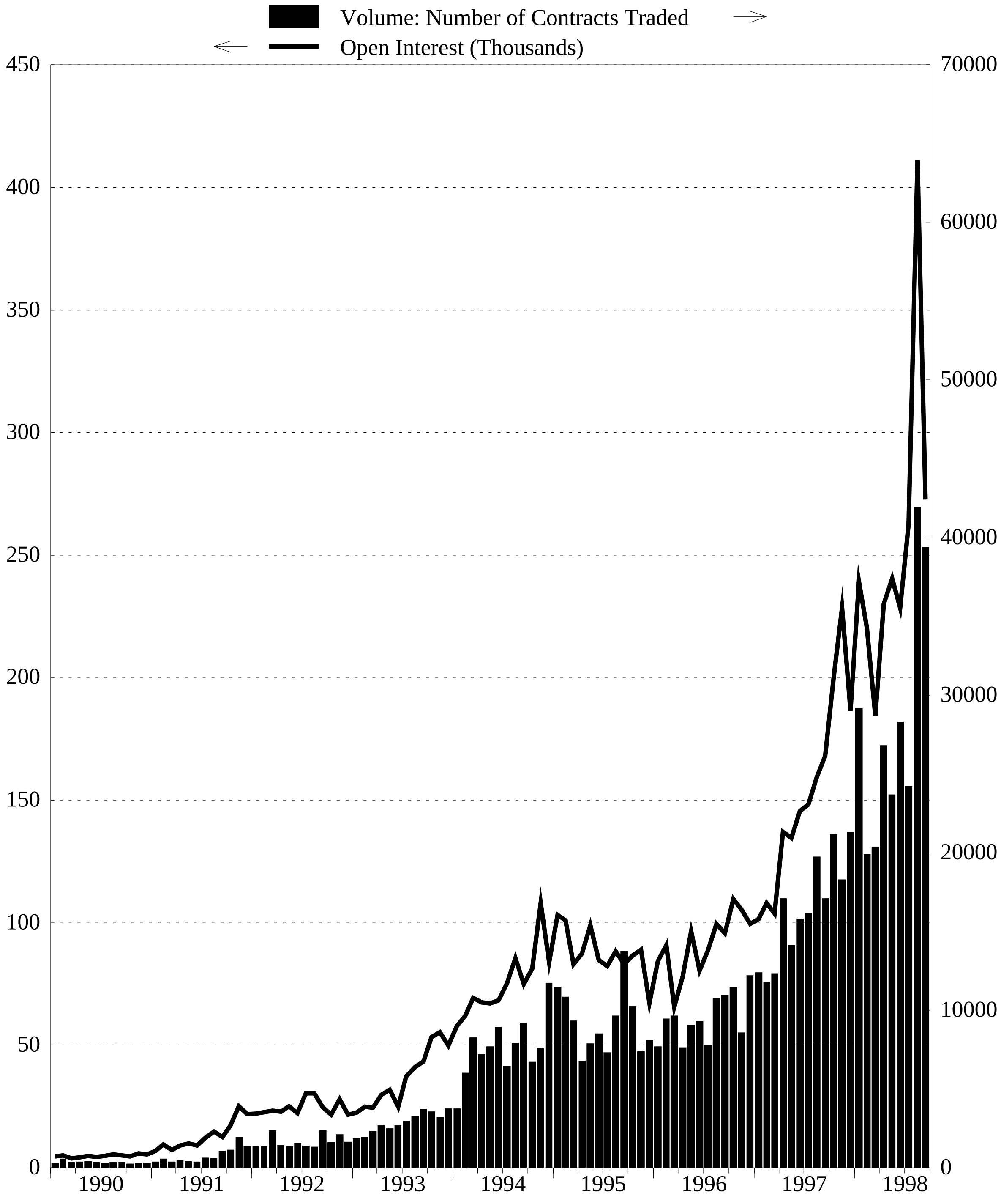


Figure 5

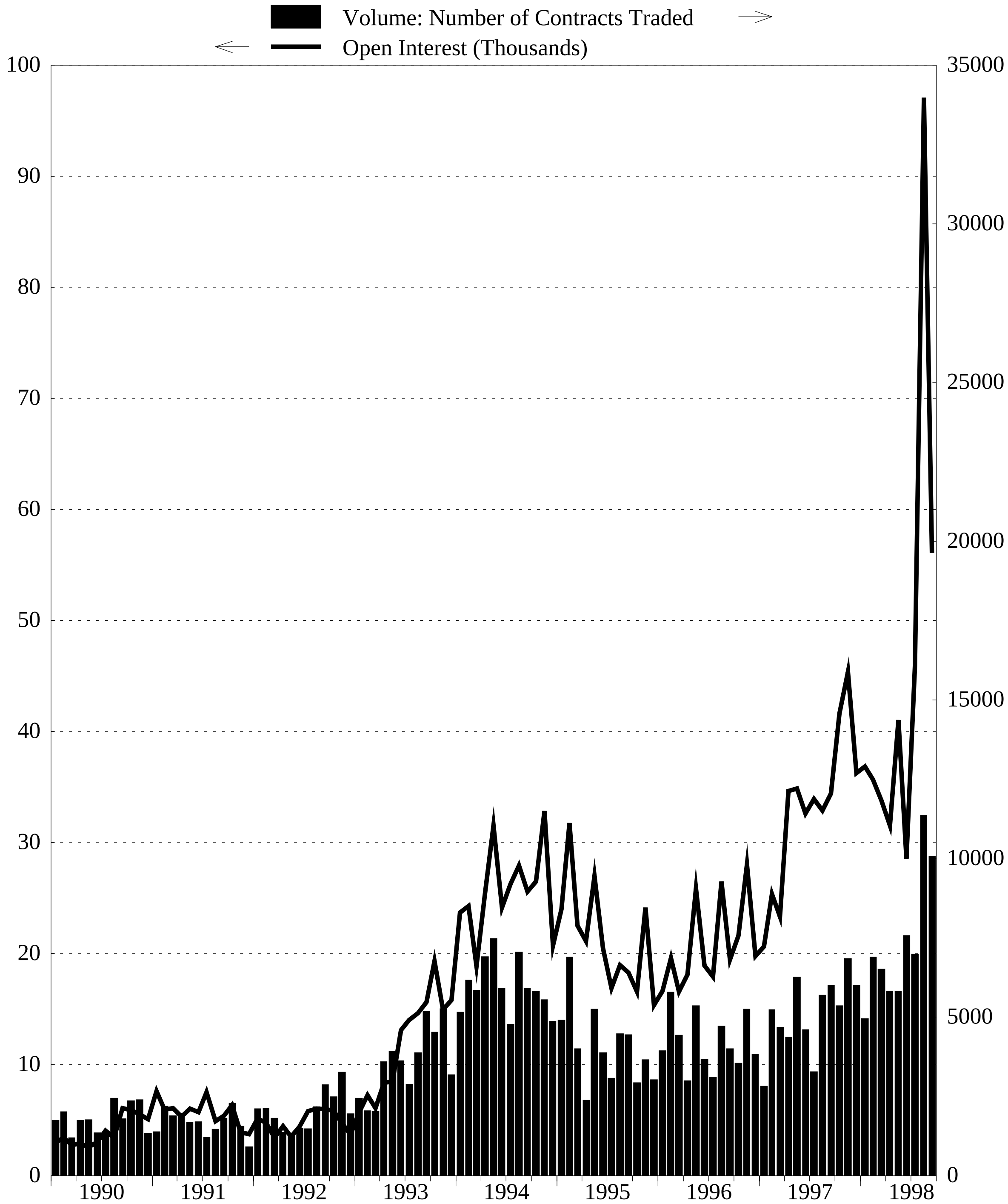
BAX 3−month Contract − Daily Average Volume
BAX 3−month Contract − Open Interest (month end)



* 1 BAX contract = $1,000,000

Figure 6

CGB 10−year Contract − Daily Average Volume
CGB 10−year Contract − Open Interest (month end)



* 1 CGB contract = $100,000

Figure 7: Ten−year and Three−month Yields

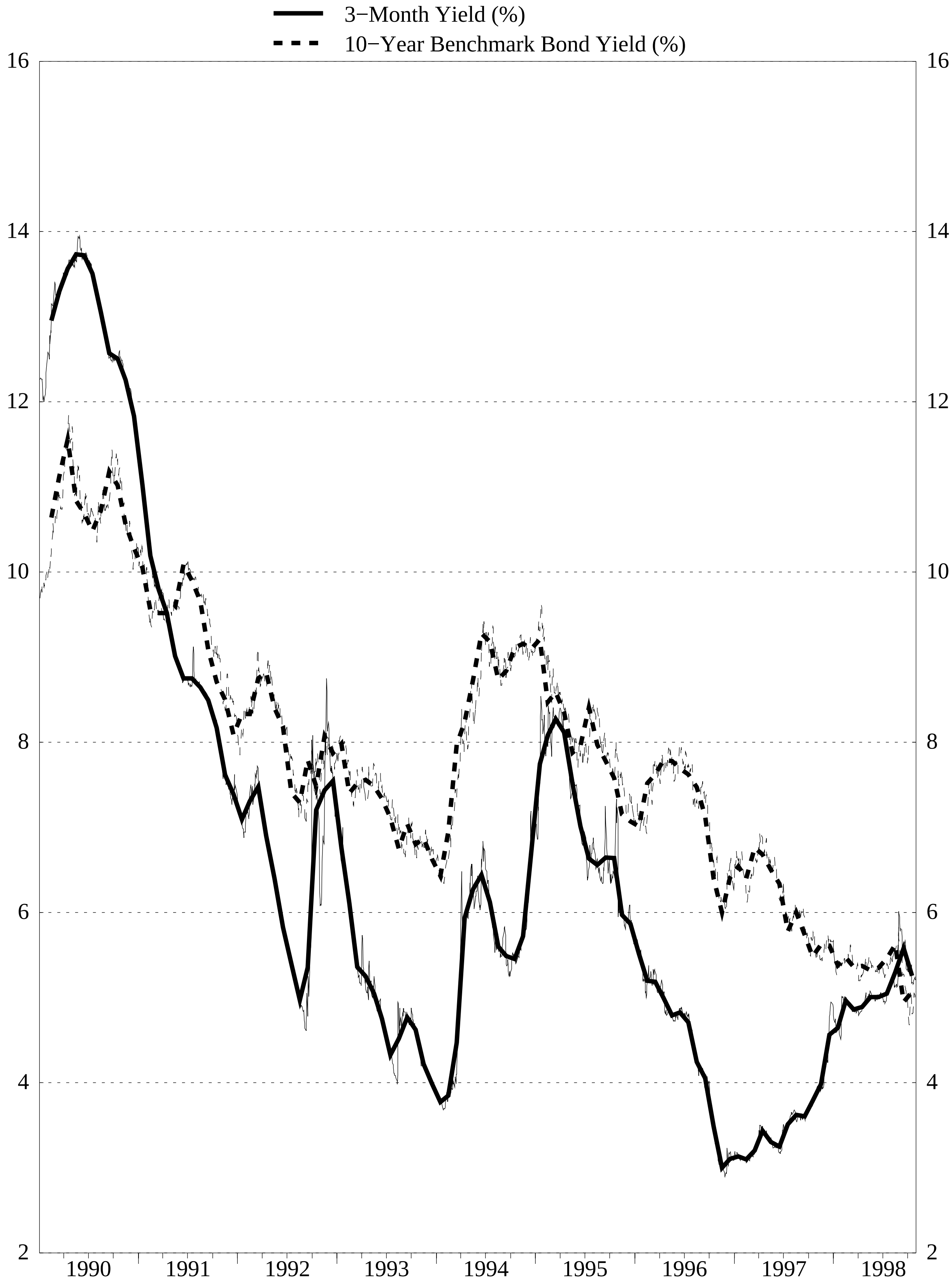


Figure 8: T−Bill Bid−Ask Spreads (Basis Points)

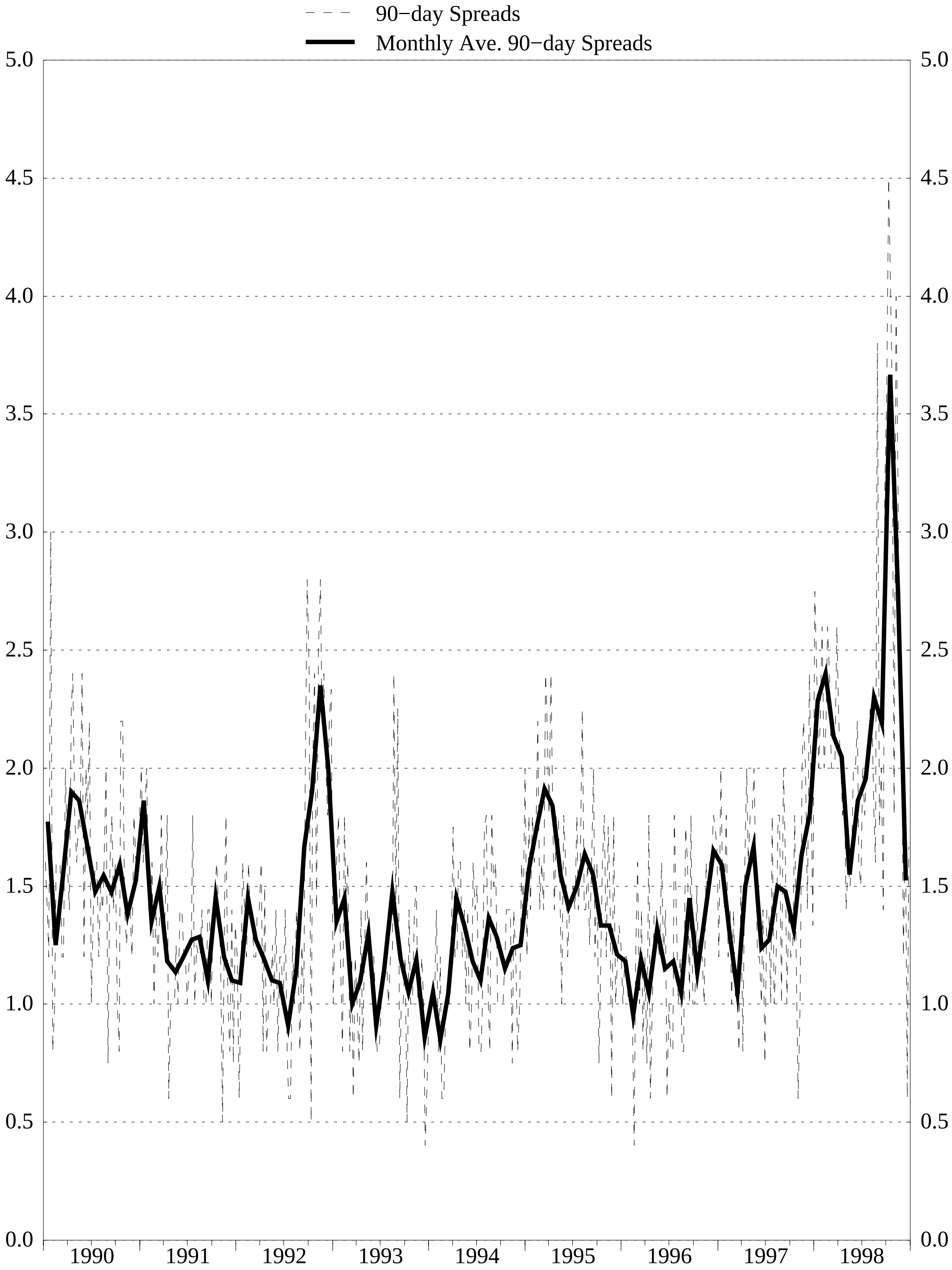


Figure 9: T−Bill Bid−Ask Spreads (Basis Points)