# Degrees of Specialness: An Empirical Analysis of the Italian BTP Repo Market

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**Abstract**

We explain the variation in the degree of specialness for bonds used as collateral in the Italian Government BTP repo market. Some of our results are similar to the findings in the US repo market even through the underlying Italian BTP bond market is structurally different than the US Treasury market. Specifically liquidity, supply and demand are significant factors that help determine the degree of specialness. Unlike US repo studies however, we find that credit risk and information uncertainty also affect the degree of repo specialness.

**JEL Classification**: *E43, G12, G15, G24*

**Key words**: *Repo, Bonds, Credit risk, Liquidity*.

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Repo or repurchase agreements are contracts for collateralised borrowing. The importance of the repo market can hardly be understated. Repo markets enable bond markets to function more effectively by providing bond market participants the mechanism to finance long and close short bond positions. Moreover, the European Central Bank and the Bank of England conduct monetary policy through the repo market (see Mitusch and Nautz 2001, Skinner, 2004, page 453). Accordingly repo transaction volumes are huge. Table I reports that on MTS, Europe's largest electronic bond market, daily repo transaction volume averages more than €50 billion. In total all repo transactions for our two-year sample period from April 1, 2003 to March 31, 2005 are worth nearly €27 trillion. Despite its economic importance however, only a few studies examine the repo market.

[Insert Table I about here]

We seek to understand why some bonds trade more on special than others on the repo market. Traders have the option to borrow at the "general collateral" interest rate by not specifying the bond that is used as collateral until a latter date when it will be chosen from a pre-defined basket of bonds. Alternatively traders can declare a specific bond as collateral at the onset of a repo transaction and pay a "special" repo interest rate on the loan. We measure specialness of bonds used as collateral in repo agreements as the difference between the general and special collateral repo interest rates. We discover that some bonds that trade "on special" really are not very special at all since the "special rate" is only a few basis points less than the general collateral rate. Yet other bonds have special repo rates that are more than 100 basis points less than the general collateral rate. Immediately one wishes to know the factors that determine the "degree of specialness", that is the spread between the higher general collateral and the lower special collateral repo rate for a given Treasury bond trading on special in the repo market.

Surprisingly there are just a few studies that examine the variations in relative repo specialness and those that do concentrate on the US repo market. For example, Moulton (2004) studies the specialness of "on the run" relative to "off the run" US Treasury bonds. However, the distinction between "on the run" and "off the run"

Treasury bonds is not relevant to European bond markets and so to generalise our understanding of the degree of repo specialness a study of the relative specialness in a European market is required.

Accordingly our first major contribution is to provide the first empirical study of the degree of specialness of Treasury bonds that trade on special in a non-US bond market. This in an important gap because the US Treasury market is structurally different than the European Treasury bond markets so the conclusions of these studies do not necessarily apply to European repo markets. Specifically the US Treasury auctions new bonds of fixed maturities staggered all along the yield curve according to a predetermined schedule. Bonds "on-the-run", the most recently issued bonds of a given target maturity, are different than bonds "off-the-run", bonds that were issued at the same target maturity before the most recent auction, because they have a slightly different remaining maturity, often have a different coupon and always carry a different ISIN number. In addition it is well known that bonds "on the run" are more desirable than bonds "off the run" as they are more liquid and therefore easier and cheaper to trade. Therefore "on the run" bonds are unique. In contrast the standard method for issuing new bonds for many European sovereigns is to offer additional tranches of existing Treasury bonds. Therefore newly issued bonds are not unique as all previous tranches of the same bond have the same coupon, the same remaining maturity, even the same ISIN number and so they are perfect substitutes for the newly issued bonds. Consequently the difference between the most recently issued European Treasury bond and the less recently issued bond is not distinct. Therefore one does not make a distinction between "on the run" and "off the run" bonds when dealing with many European Treasury markets. This is a problem because to date the literature defines supply in terms of "on the run" bonds. One challenge we face is to test Duffie's (1996) prediction that specialness of a given bond in the repo market is related to restriction in supply in the cash market when there is no such thing as an "on the run" bond. We resolve this problem by constructing a direct measure of supply for a given bond from the intra-daily data available from the MTS Time Series Database and so provide a direct test of Duffie (1996).

Our second major contribution is to show that two additional factors help determine the degree of specialness in the repo market. Firstly, credit risk plays a role in determining the degree of specialness in addition to liquidity, demand and supply effects. In essence a repo is a collateralised loan. Should a counterparty fail to repay the repo loan the collateral will protect the investor. However if interest rates were to spike upwards the value of the collateral can be less than the value of the amount advanced thereby exposing the investor to credit losses. Therefore bonds with higher duration are less desirable and trade less on special as the collateral can expose the investor to counterparty credit risk. We note that our dataset of repo transactions are particularly susceptible to this problem as the repos that we examine are "buy sellbacks" rather than "classic" repos. As we explain later in more detail "buy sellbacks" contain less protection against counterparty credit risk than the "classic" repo. In fact we find evidence of counter party credit risk as we find that the degree of specialness on high duration bonds are lower than the degree of specialness of bonds with lower durations. In contrast Duffie (1996) while recognising the potential of credit risk as an explanatory factor for repo specialness suggests that in the US repo market the influence of credit risk is overshadowed by demand, supply and liquidity factors.

Secondly, we find that information uncertainty increases the degree of specialness. It is conventional to suggest that the bid ask spread measures liquidity. Therefore higher bid ask spreads should be associated with lower liquidity and a lower degree of specialness of the bond. However bid ask spreads are also influenced by information uncertainty. Moreover bonds included in our database must meet certain listing requirements ensuring that all bonds have a reasonable amount of liquidity. Therefore variations in the bid ask spread can reflect differences in information uncertainty rather than differences in liquidity as all bonds in our sample already have a significant level of liquidity. As discussed later in more detail, increases in the bid ask spread caused by information uncertainty could be correlated with speculative demand and therefore be associated with an increase (rather than decrease) in the degree of specialness. In fact we find a positive rather than a negative relationship between the bid ask spread and the degree of specialness for the shorter term repos thereby supporting the idea that information uncertainty helps drive the bid ask spread and is associated with an increase in speculative demand and repo specialness.

Interestingly we find a negative relationship between the bid ask spread and the degree of specialness for the longer term repos suggesting that longer term repos are subject to stronger liquidity constraints and/or are less used for speculative purposes than shorter term repos.

An important advantage of this study is the quality of the data. We use the MTS Time Series database that is provided directly by the MTS European electronic bond market. Therefore our data is less likely to contain reporting errors and it incorporates the view of a large group of market participants, both market makers and price takers, rather than the view of a single or a group of dealers. Additionally this study is the first to incorporate intra-daily data so that we are able to develop a direct measure of the available supply of a given bond rather than a proxy based on the "on the run" status of the bond. This is especially important for European repo studies because, as mentioned earlier, there is no clear distinction between "on the run" and "off the run" bonds so proxies for supply such as the bid to cover ratio on "on-the-run" bonds used for studies of the US Treasury repo market are inappropriate for the European repo market.

Duffie (1996) develops a theory that bonds go on special because the owners of a given bond are inhibited in some way from providing the bond as collateral in a repo transaction. Accordingly those who short these bonds have difficulty in covering their short positions in the repo market. This means that those traders needing temporary ownership of the bond to cover short positions are willing to lend via a reverse repo at low special repo rates. For example, a trader may wish to cover a short position on a bond that is rarely offered as collateral in a special repo. The trader can induce a counterparty to provide temporary ownership of the rarely collateralised bond by offering to finance the long position of the counterparty at a very low special collateral rate. The counterparty delivers the bond to the trader and the trader in turn lends the agreed amount to the counterparty at an attractive rate. Then the trader can use the special collateral to settle their outstanding short position in the bond. Of course the trader must return the bond once the repo transaction matures and this is accomplished by re-purchasing the bond in the bond market or by renewing the repo.

Sundaresan (1994) and Keane (1995) show that specialness of a given "on the run" US Treasury bond depends upon the dynamics of Treasury auctions. Specifically the higher the bid to cover ratio, and the larger the portion of an issue allocated to buy and hold non-dealer investors, the greater the restrictions in supply in the bond market so the greater the degree of specialness of these bonds in the repo market. Jordan and Jordan (1997) show that bonds on special in the repo market command higher prices in the cash market. Additionally Jordan and Jordan (1997), Longstaff (2000) and Buraschi and Menini (2001) study the relation between spot repo rates and future repo specialness. Jordan and Jordan (1997) and Longstaff (2000) find that general collateral rates are consistent with the expectations hypothesis because forward repo rates derived from the term structure of repos are generally consistent with the realised overnight repo rate. In other words the repo rate on a term repo beginning, say in two days time T + 2 and terminating in three days time T + 3 is generally consistent with the realised overnight repo that evolves two days later. However Buraschi and Menini (2001) find that forward repo rates on special repos overestimate the realised overnight special repo rate. Of particular interest to this paper is Jordan and Jordan (1997) who find that the liquidity premium on "on–the-run" US Treasury bonds is partly determined by repo specialness and Moulton (2004) who finds that the special repo spread between "off–the-run" and "on-the-run" US Treasury bonds is related to the US Treasury bond auction schedule, auction tightness and macro economic conditions such as interest rate volatility.

Our results show that credit risk and information uncertainty are new factors that help determine the degree of specialness for Italian Treasury bonds. Meanwhile we confirm earlier work in the US repo market by finding that supply, demand and liquidity are important factors that determine the degree of specialness of Italian Treasury bonds repoed in the electronic bond market. In summary we find that the degree of specialness increases in information uncertainty, demand and liquidity but decreases in credit risk and supply. We also find that a fixed effects "dummy variable" specification of our regression model is appropriate where each bond has its own unique constant. This implies that bonds on special have their own unique level of specialness that is not explained by supply, demand, and liquidity factors or credit risk and information uncertainty.

In the next section we provide a short introduction to the MTS repo market. In section II we develop our model that seeks to explain the specialness of bonds in the repo market. In section III we discuss our data and our empirical analysis of our model is reported in section IV. Section V summarises our results and presents our conclusions.

## I The MTS Repo Market

On MTS a typical purchase size for a German Bund or an Italian BTP bond would be €5 or €10 million. The trader must finance the purchase when the trade settles typically two or three business days later. A common option is to repo the bond. This entails agreeing to sell the bond on the repo settlement date and repurchase it at some other date according to the term of the repo. Specifically an "overnight" ON1 repo is the shortest maturity repo where the repo settles on the trade date T and the bond is repurchased the next business day T+1. A "tomorrow next" TN repo has a slightly longer term as the repo settles at the trade date T plus one business day T+1 and the bond is repurchased the following business day T+2. Similarly longer term repos such as the "spot next" SN and the "spot one week" S1W both settle at T+2 and the bond is repurchased at T+3 and T+9 business days respectively. As the trader can align the settlement date of the sale of the bond on the first leg of the repo transaction with the settlement date of the bond purchased in the bond market, repos can provide the funds needed to purchase the bond in the bond market. The price for doing this is the obligation to repurchase the bond on the second leg of the repo transaction at a higher price. The difference between the repo sale and higher repurchase price implies an interest rate called the repo rate.

In essence a repo transaction is a collateralised loan. If the party doing the repo fails to repurchase the bond in the second leg of the transaction the counterparty has title to the bond securing the repo loan and can use it to offset or eliminate losses. A "general collateral" repo is one where the collateral is very generally defined as say "Italian" meaning that any Italian sovereign bond can be delivered as collateral where as a "special" repo is one where a bond with a specified ISIN number is to be delivered as collateral.[1]

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[1] With effect from 25th May 2001, the ISMA European Repo Council has indicated that the following list of Italian Government bonds are deemed to be acceptable as collateral on an Italian general collateral repo transaction: CCTs (Floating Rate), BTPs (Fixed Coupon), BOTs (Zero Coupon, less than one year maturity) and CTZs (Zero coupon, more than one year maturity).

Repos are also classified as “buy sellback” or “classic”. A “buy sellback” repo is structured and documented as two separate transactions whereas a “classic repo” documents both transactions together as one legal transaction. In terms of economic function, a buy sellback and a classic repo are precisely the same. Legally however a classic repo offers greater protection against counterparty credit risk for the lender. Unlike buy sellbacks the lender can demand additional collateral if interest rates spike upwards and the value of existing collateral falls below the amount advanced. Virtually all repo transactions on MTS are buy sellback repos.

The counterparty to the repo does the reverse and in effect provides a collateralised loan. The motivation for doing a reverse general collateral repo is simply to earn interest. However in doing a reverse special collateral repo, the counterparty can have other motives. For instance, the counterparty can use the bond purchased in the first leg of a reverse repo transaction to cover a short position in that bond. The need to obtain temporary ownership of a given bond gives rise to special repo rates on particular bonds, the stronger the need, the lower the special repo rate. As a consequence, the repo rate charged on general collateral repos is a market-determined rate that reflects the general very short-term interest rate environment but the rate on special repos, being driven by unique market conditions of a specific bond, can be far below the general collateral rate.

As an illustration of the differences between European general and special collateral interest rates we examine the TN repo. Table II Panel A shows that for the two-year period ending on March 31, 2005 the TN special rate on MTS is on average only nine basis points cheaper than the general collateral rate. So “on average” it does not appear that bonds underlying special collateral repos are “on special” by very much. However the special rate is much more variable, has a longer left tail and higher peakness than the general collateral rate. Therefore the difference between the general and special collateral repo rates can be much greater than suggested by mean differences alone. Panel B of Table II shows the histograms of the general and special collateral TN repo rates. Clearly the special repo rate’s distribution lies to the left of the general repo. Also note that while the special repo rate can be negative, this is a very rare occurrence. Fleming and Garbade (2004) observed this phenomenon in the US Treasury repo market finding that when the costs of failing to meet a delivery obligation on a short position in the cash market is high, dealers are willing to pay negative repo rates in order to have access to the bond needed to meet their delivery requirements.

[Table II about here]

To give us some idea of the time variation in repo specialness we plot the degree of specialness for the 5.25% BTP of 1/08/17 and the 4.25% BTP of 1/08/13 for the TN term in Figure 1. Notice that both bonds do not smoothly "go on" and then "off" special. Instead specialness remains fairly steady at around 10 basis points but then specialness sharply increases to 50 basis points or more for a few weeks. We seek to understand the reasons for this variation in repo specialness.

[Insert Figure 1 about here]

## II The model

A bond that is "on special" should have a repo rate that is below the general collateral rate. The more on special a given bond is then the greater this difference should be. We measure the degree of specialness Special for a given bond as the difference between the general collateral repo rate otherwise available in the market and the special repo rate for that bond. Therefore as the degree of specialness increases the special collateral rate decreases relative to the general collateral rate. Our intention is to seek proxy variables suggested by the literature and by our understanding of the repo market that can explain the degree of specialness of bonds repoed in the marketplace.

Duffie (1996) and Jordan and Jordan (1997) suggest that restrictions in supply in the bond market help explain the specialness of the bond in the repo market. Those needing temporary ownership of the bond cannot purchase it in the bond market and so turn to the repo market and offer special rates to finance the inventory of holders of the bond. Sundaresan (1994) and Keane (1995) proxy restrictions in supply as the degree of "auction tightness" measured as the bid to cover ratio for "on the run" bonds. As the bid to cover ratio increases, supplies are more restrictive relative to demand and so specialness increases. Another proxy for supply conditions is the portion of an "on the run" bond issue that is allocated to dealers at auction. As the portion allocated to dealers increases, less bonds are allocated to buy and hold investors. Since dealers are more willing to supply collateral than buy and hold investors, supply restrictions ease and specialness decreases.

Unfortunately the above measures of restriction in supply does not generalise well outside of the US Treasury bond market. As discussed previously new issues of US Treasury securities are regularly auctioned for a fixed set of maturities according to a predetermined schedule. This creates a distinct class of "on the run" bonds that can be used to determine the degree of auction tightness and to measure the portion of a bond issue that is held by buy and hold investors of these distinct "on the run" bonds. In contrast additional tranches of existing Italian Treasury bonds are issued when the Sovereign seeks additional funds. Therefore newly issued bonds are not unique as all previous tranches of the same bond are perfect substitutes of the newly issued bonds. Consequently there is no difference between the most recent issued Italian Treasury bonds and the less recently issued bonds. Therefore "auction tightness" and the portion of a given bond issue held by dealers must be measured relative to the entire bond issue. It is an impossible task to measure the portion of a bond issue held by dealers as bonds issued several auctions in the past to dealers may have passed into the hands of buy and hold investors in the meantime. Moreover if one were to attempt to measure "auction tightness" as the bid to cover ratio for the latest Italian Treasury auction one would have a measure relevant for a few bonds as there are only five or six issues that are regularly re-opened. Yet many Italian Government bonds trade on special even though these bonds are not re-opened. Our challenge is to develop a measure of supply for the entire Italian Government bond market rather than a subset of the bond market.

Fortunately our data is detailed enough for us to measure the daily supply of a given bond directly from the underlying bond market data. We measure the supply of a bond, Supply, as the time-weighted average volume of a given bond available for sale at the top three levels of the dealer's ask price for each trading day. We expect an inverse relation between specialness and the supply of a bond because as the supply of a bond decreases in the bond market there are fewer bonds available for purchase. Facing a restriction in supply dealers needing temporary ownership of the bond must compete more vigorously in the repo market by offering attractive special repo rates and so specialness increases.

The difference between daily buyer initiated volume and seller initiated volume in the bond market Trade Imbalance provides a complementary measure of supply and demand conditions for a given bond. As the trade imbalance of a bond increases there is buying pressure in the bond market, traders accumulate positions in the bond and dealers have low inventory holdings. This reduces supply so those traders needing the bond to cover short positions turn to the repo market. In turn this leads to lower special repo rates and a higher degree of repo specialness. Therefore as the trade imbalance of a bond increases, its degree of specialness also increases. Moulton (2004) suggests that bond market conditions influence speculative demand for short positions and therefore the demand for reverse repos. As interest rate volatility Vol increases speculative demand should increase leading to larger short positions. As speculative demand increases and more bonds are shorted then the demand for reverse repos and consequently specialness increases as well. We measure volatility as the at the money interest rate cap implied volatility on one-year Italian interest rates. This information is collected from *DataStream*. As interest rate volatility increases, speculative demand and specialness increase.

We also consider two variables based on our understanding of the repo market. We suggest that the actual amount of a bond that is repoed on a given day is a summary measure of demand. We expect a downward sloping demand curve where as the amount actually repoed increases the price of doing the repo decreases (i.e., specialness decreases). Therefore as the amount of a given bond in € millions that is actually repoed on a given day Quantity increases, the degree of specialness would decrease.

Surprisingly credit risk has not been considered in the literature. As a repo transaction is in essence a collateralised loan the specialness of the repo rate should be related to the quality of the collateral. It is well known that repo transactions are subject to counterparty credit risk because if a dealer fails to repurchase a bond as required by the second leg of the repo, and if interest rates have spiked upwards in the meantime, then the value of the collateral can be less than the amount advanced. Consequently the counterparty doing the reverse repo can experience default losses. Fabozzi (2000) reports instances of these events in the US repo market. Our measure of the quality of collateral Quality is the modified duration of a bond that is trading on special. As a bond trades at different prices throughout the day, we measure the duration based on the average volume weighted price of the bond for the day. We expect that the higher the duration of a bond, the greater the potential for credit risk exposure so the less desirable is the collateral. Consequently the high duration bond will trade less on special so we expect an inverse relation between Quality and the degree of specialness of a given bond.

Duffie (1996) finds that given two bonds that are otherwise identical, the more liquid bond trades more on special. Evidently liquid bonds are more often shorted and consequently are in greater demand as collateral in repo transactions. We consider the number of intra-daily quote updates divided by the time in seconds it remains effective number of seconds in the effective trading day[2] for a given bond that is traded special on the repo market as a measure of liquidity of a bond.[3] Therefore as the number of intra-daily quote updates per second increases liquidity as well as specialness increase.

If the liquidity of the underlying bond were indeed positively associated with specialness, then this would imply that repo transactions tend to be concentrated in certain bonds. For example, one common reason for shorting a bond is the speculation that at a given maturity range, yields are too high.[4] Given a choice among which bonds in the target maturity range to short, speculators would choose the more liquid bond as it would be easier to repurchase when needing to close their position. This implies that repo transactions would be concentrated in a few of these target bonds. Therefore not only would the more liquid bond be more on special, but would be more frequently repoed as well. We examine this aspect of liquidity by looking at the

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[2] The effective trading day is the number of seconds that two-way quotes are posted for a given bond. The MTS market obligates market makers to post two-way quotes for a minimum of five hours per day so baring trading suspensions the effective trading day is at least five hours.

[3] We chose the number of intra-daily quote updates because more liquid bonds are more actively quoted on an intra-daily basis. We compute quote updates per second because MTS stopped recording every single quote update after August 31, 2003 and instead recorded updates every few seconds during times of high quoting intensity.

[4] In fact, Bloomberg terminals include two analytical utilities, the Butterfly/Barbell Swap and the Butterfly/Barbell Arbitrage sub-routines that are designed to help the trader to execute this kind of trading strategy.

number of daily repo trades "Trades". We expect that as the number of daily repo trades in a given bond increase specialness increases as well.

Finally, we include the daily time weighted average of the bid ask spread in the bond market for a bond trading on special in the repo market. This variable Bas is constructed from the inter-daily data as

$$\text{Bas} = \left[\frac{\text{Ask} - \text{Bid}}{(\text{Bid} + \text{Ask})/2}\right] \text{x} \left(\frac{\text{duration}}{\text{Total Time}}\right)$$

where Ask and Bid are the ask and bid prices respectively, duration in the time in seconds that the bid and ask remains in effect and Total Time is the time from the first proposal after 08:15 (the time the MTS market opens) to the closing time at 17:30.[5]

According to Duffie (1996) liquid bonds are more on special and a common measure of liquidity is the bid ask spread. Therefore we expect that the smaller the bid ask spread the more liquid the bond is and therefore the more on special the bond will be. However differences in the bid ask spread can be caused by information uncertainty as well as differences in liquidity Moreover bonds selected for inclusion in the MTS system must already be "liquid" to some degree.[6] Therefore differences in the size of the bid ask spread can be driven by uncertainty as well as by liquidity and it is uncertainty that drives speculative demand. It is possible that the bid ask spread widens as information uncertainty increases. In turn information uncertainty attracts speculative demand leading to an increase in specialness. In summary our measure of the bid ask spread can be positively or negatively associated with the specialness depending if changes in the bid ask spread is being driven by differences in uncertainty or liquidity respectively. In summary our model is as follows.

$$\begin{aligned}\text{Special}_{it} = {} & \beta_0 + \beta_1\text{Supply}_{it} + \beta_2\text{Trade Imbalance}_{it} + \beta_3\text{Vol}_{it} + \beta_4\text{Quantity}_{it} \\ & + \beta_5\text{Quality}_{it} + \beta_6\text{Trades}_{it} + \beta_7\text{Quotes}_{it} + \beta_8\text{Bas}_{it} + \varepsilon_{it} \quad (1)\end{aligned}$$

[5] The MTS market obligates market makers to post two-way quotes for a minimum of five hours per day. Consequently there are times when several market makers stop posing quotes so the bid ask spread widens dramatically, as much as 1,700 basis points. To avoid this noise we ignore bid ask spreads that are greater than 50 basis points.

[6] For instance, Italian government bonds must have an outstanding issue size of at least €5 billion to ensure there is considerable interest in trading the bond and as mentioned in footnote three, market makers are obligated to make two way quotes for at least five hours a day.

where,

Special $_{it}$: General collateral less the special repo rate for bond ‘i’ at date‘t’.

Supply $_{it}$: The daily average of the sum of bonds available for purchase at the top three levels of the ask for bond ‘i’ at date ‘t’. $\beta_1$ is expected to be negative.

Trade Imbalance $_{it}$: The daily buyer initiated volume less the seller initiated volume in the bond market for bond ‘i’ at date ‘t’ that trades on special in the repo market. $\beta_2$ is expected to be positive.

Vol $_{it}$: The one-year Italian interest rate cap implied volatility applicable for bond ‘i’ at date‘t’. $\beta_3$ is expected to be positive.

Quantity $_{it}$: The nominal quantity in € millions of bond ‘i’ sold as collateral as of date‘t’. $\beta_4$ is expected to be negative.

Quality $_{it}$: The average modified duration of bond ‘i’ during day‘t’. $\beta_5$ is expected to be negative.

Trades $_{it}$: The number of repo transactions involving bond ‘i’ as of date‘t’. $\beta_6$ is expected to be positive.

Quotes $_{it}$: The number of quote updates of bond ‘i’ during day ‘t’ divided by the number of seconds in the effective trading day . $\beta_7$ is expected to be positive.

Bas $_{it}$: The daily time weighted average of the bid ask spread in the bond market of bond ‘i’ during day‘t’. $\beta_8$ is expected to be positive if Bas is associated with speculative demand or negative if associated with liquidity.

**III Data selection**

We use the MTS Time Series database from April 1, 2003, the first date available on this data set, until March 31, 2005 the last update that we have obtained. The MTS Time Series Database contains the details of and the transactions concerning all the bonds traded on MTS, Europe’s largest electronic bond market. As such the data is unique as it represents data from the entire market rather than just one dealer. The database contains daily and intra-daily information on more than 1,000 bonds. The daily data includes identifying information such as the ISIN number, pricing information such as the price and yield (at or near 17:00 Central European Time) and daily trade statistics for each bond such as the total volume and daily average bid/ask spread. The intra-daily data includes the price, yield and volume for the best proposals at the top three levels for the bid and ask and a separate intra-daily file on the fills that gives the details of completed trades including price and volume information. A separate repo market file reports daily data on all general collateral and special collateral repos. This information identifies the bond (if special collateral) or the type of bond (if general collateral) used as collateral and includes details such as the repo rate, the amount of the collateral and the repo term. The daily, intra-daily and repo files are all linked together via the ISIN number to a separate cross-sectional file that contains the details of a given bond including the issue and maturity date, coupon, coupon periodicity, day count convention and so on. Uniquely, the cross-sectional file also reports details of the quoting obligations of dealers using the MTS system for a given bond including the minimum trade size and the maximum spread that can be quoted. Further details on the structure of this database can be found in Dufour and Skinner (2004).

We require a homogeneous set of repo transactions to ensure that we isolate the influences that determine the degree of specialness of a given bond. We choose all special repos of Italian BTP bonds because these are straight, semi-annual coupon pay bonds with no optionality or inflation protection. More importantly, a large set of ON1, SN, TN, and S1W general collateral rates for Italian bonds are available for most of the trading days over the two-year sample period whereas for many business days all general collateral rates for other large European bond markets such as Germany and France are missing. All Italian repos are “buy sellbacks” rather than “classic” repos.

For each day we collect the ON1, TN, SN, and S1W general collateral Italian repo rates and subtract from them the corresponding term special repo rate for all BTP special collateral repos. The resulting statistic is our measure of the degree of specialness of the bond, Special. Thus we run equation (1) on four data sets, one each for the ON1, TN, SN and S1W repo terms.

Table III shows the distribution of repo specialness by repo term for BTP bonds for the two-year sample period ending on March 31, 2005. There are more than 50 BTP bonds that trade on special for each of the ON1, TN, SN, and S1W repo terms. The number of observations varies by repo term from a minimum of 2,045 for the S1W to 23,141 for the SN.[7] Typical of financial data the distribution of repo specialness displays excess kurtosis and positive skew. Evidently the degree of specialness decreases in the term of the repo as we move from the ON1 repo to the SN repo. However the SN and S1W appear to have about the same degree of specialness. For example, the shortest-term repo ON1 appears to have the highest degree of specialness, as the mean at 17 basis points is higher than the longer-term TN repo which in turn at nearly 8 basis points is higher than the means of the SN and S1W repos. Additionally almost 4% of the ON1 repo observations have a degree of specialness greater than 50 basis points whereas the corresponding percentages for the longer term TN, SN, and S1W repos are approximately 1%, 0.6% and 0.4% respectively. Also, for specialness above 10 basis points the percentage of observations in each specialness cell decreases with term except for the SN and S1W repos. Finally the dispersion in the degree of specialness decreases with the term. In fact, the shortest ON1 repo has the largest standard deviation of specialness whereas the longest term S1W has the lowest standard deviation.

[Insert Table III about here]

## IV Empirical analysis

We check the data for high collinearity. Table IV shows that with just two exceptions the sample correlation coefficient between all the explanatory variables stays below 0.45. The exceptions are the correlation between Trades and Quantity and the correlation between Quality and the Bid Ask spread Bas. The high correlation between Trades and Quantity is not unexpected because with more trades the total

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[7] We also examined the data for errors and conclude that one observation for the ON1, nine observations for the TN, and three for the SN repo terms are not valid as they show "special" repo rates that are more than 15 basis points larger than the general collateral rate. Some of these observations are obviously erroneous as the special rate is missing the first digit. A few (54) other observations show "negative specialness". However we believe these observations are valid as we use daily average measures of general collateral and special repo rates so a downward movement of the general collateral rate at the end of the day can result in negative specialness for a special repo traded more heavily earlier in the day. We conducted our empirical work with and without all negative specialness observations and find the same results that we report in this paper.

amount of a given bond repoed will increase.[8] However as these two variables measure different influences that determine the degree of specialness, liquidity and realised demand, it was felt necessary to include them.[9] Similarly the high correlation between Quality and Bas is possible because both can be related to speculative demand. Speculators will wish to trade in bonds with higher modified duration, our proxy for Quality, and as mentioned previously the Bas can be related to information uncertainty and therefore speculative demand. Again however, these two variables measure different influences that determine the degree of specialness, credit risk and speculative demand (liquidity) so it was felt necessary to include them. Later we find that in spite of the high sample correlation between these two sets of variables, they enter the regression in a highly significant way. We conclude therefore that our results are not influenced by high collinearity.[10]

[Insert Table IV about here]

The ON1, TN, SN, and S1W data are pooled time series and cross sectional unbalanced panel data so it is possible that the data may have autocorrelation and heteroscedasticity. We start by assuming that all coefficients in (1) are constant for all bonds and run OLS. Next we use the Durbin – Watson test statistic to detect that for all four datasets, ON1, TN, SN, and S1W, the regression errors display positive first order autocorrelation. Therefore we correct the pooled cross sectional time series data for autocorrelation and heteroscedasticity by including lagged terms and using White's (1980) heteroscedasticity adjustment. In summary our preliminary investigation suggests that we should estimate (1) using an autocorrelation and heteroscedasticity consistent estimator such as the Newey and West (1987) procedure.

[8] The relation between trades and quantity is not perfectly collinear as the amount repoed per trade varies.

[9] For example, one daily repo trade of €1 billion represents a repo with lower liquidity than one that has 1,000 trades of €1 million in one day even though both repos have the same daily quantity. In the later case we expect that a high concentration of trades in the repo is caused by a greater amount of liquidity in the underlying bond and is therefore associated with a higher specialness than the repo with the single large transaction. In the meantime both repos have the same realised demand so for this reason the specialness for both repos should be similar. To disentangle these effects both Trades and Quantity should be included in the model.

[10] We also looked at what happened to the other regression coefficients as we dropped, one by one, the candidate variables for high collinearity from the regression. We note that the remaining coefficients maintained their significance and coefficient values.

However this specification of (1) assumes no individual bond is different than another. We do not believe this is the case. Instead we hypothesize that some bonds trade more on special than others because some traders believe these bonds are uniquely suited to their trading strategy. For example, a given bond may be the current "cheapest to deliver" on a futures contract so this bond is still more attractive than others even when we account for common key factors, such as liquidity and quality of collateral, considered important to those seeking to provide financing on the repo market. This naturally leads us to consider the "dummy variable" model where there are constant slope coefficients for all bonds, but each bond has its own unique intercept.

Judge et al. (1985, page 521) suggests testing for the "dummy variable" specification using an F-test. Procedurally we estimate (1) twice, the first regression is unrestricted in that we estimate different intercepts for each bond and the second is restricted in that the intercept is forced to be the same for all bonds. The F-test examines the significance of the increase in residual sum of squares when imposing the restriction. We reject the null and implicitly accept a dummy variable specification for large values of the test statistic. As our regressions are corrected for heteroscedasticity the usual F-test statistic is actually distributed $\chi^2$. The first panel of Table V reports the results of this test for the period April 1, 2003 to March 31, 2005 for the ON1, TN, SN, and S1W regressions clearly showing that individual intercepts should be included in our specification of (1). Therefore our model is now specified as,

$$\begin{aligned}\text{Special}_{it} &= \alpha_i + \beta_1\text{Supply}_{it} + \beta_2\text{Trade Imbalance}_{it} + \beta_3\text{Volatility}_{it} + \beta_4\text{Quantity}_{it} \\ &\quad + \beta_5\text{Quality}_{it} + \beta_6\text{Trades}_{it} + \beta_7\text{Quotes}_{it} + \varepsilon_{it} \qquad (2)\end{aligned}$$

where the parameter $\alpha_i$ represents the intercept for the individual bond i.

[Insert Table V about here]

We next consider whether the intercept coefficients are fixed or random. The random effects specification of (2) suggests that the intercept coefficients $\alpha_i$ are composed of two elements, $B_1$ and $\mu_i$ where $B_1$ represents the "average" effect of all constants and $\mu_i$ represents the deviation from the "average" intercept due to the individual effect (see Judge et al. 1985, page 521-2). The random effects model then suggests that the individual intercept component $\mu_i$ are iid and has a mean of zero E [$\mu_i$] = 0, constant variance E [$\mu_i^2$] = $\sigma^2_\mu$ and no correlation amongst the individual effects E [$\mu_i\mu_j$] = 0 for i ≠ j. The importance is that if the effects are random then incorporating this specification results in a more efficient estimator that reduces the standard errors of the coefficient estimates.

Judge (1985, page 527-8) recommends that we use the Hausman (1978) test to determine whether a fixed or random effects specification is best. The testing strategy is to estimate (2) twice, first using the less efficient fixed effects estimator and then again with the more efficient random effect estimator. We then test to see if the coefficient vectors of the two regressions are significantly different. If they are then we should use the random effects specification of (2). The resulting test statistic is distributed $\chi^2$ with a number of degrees of freedom equal to the number of coefficients in (2) excluding the constant. The results of the Hausman (1978) test are reported in the first panel of Table V for the period April 1, 2003 to March 31, 2005. Clearly we fail to reject the null hypothesis so we implicitly accept the fixed effects specification of our model as stated in (2).

It now remains to run (2) on the ON1, TN, SN, and S1W data sets for the two-year period ending on March 31, 2005. The results of this exercise are reported in the first panel of Table VI. Overall the regressions explain about 35% and 25% respectively of the variation in repo specialness for the smaller sample size ON1 and S1W repo terms and about 20% of the larger sample size TN and SN repo terms.

[Insert Table VI about here]

Looking at the details, we first examine supply and demand effects. According to Duffie's (1996) model specialness increases in demand and decreases in supply. We find strong support for this model for all repo terms as Supply, Trade Imbalance and Quantity are always of the correct sign and with just three exceptions, are statistically significant. The exceptions are for the ON1 repo term for the Supply and the SN and S1W repo terms for the Trade Imbalance variables respectively. We conclude that Duffie's (1996) model is well supported for all terms.

According to Moulton's (2004), bond market conditions influence speculative demand and therefore repo specialness. Our proxy for speculative demand, Vol, is always of the correct sign and is significant in two cases, namely for the ON1 and S1W terms. Moreover the bid ask spread Bas is positively related to the degree of specialness and is significant for the shorter-term ON1, TN and SN terms suggesting that the Bas measures information uncertainty rather than liquidity. This result is consistent with the speculative demand story. That is the bid ask spread widens as information uncertainty increases rather than as liquidity decreases as the MTS database only includes bonds that already have a significant amount of liquidity. In turn information uncertainty attracts speculative demand leading to an increase in specialness. Interestingly we find that the bid ask spread bas is negatively associated with the degree of specialness for the S1W term implying that liquidity rather than speculative demand is the driving influence of the bid ask spread for longer term repos. We conclude that Moulton's (2004) suggestion that speculative demand increases the degree of specialness is supported by the data. We also conclude that the bid/ask spread Bas is driven by and that specialness is positively related to information uncertainty for the shorter term repos.

We next examine liquidity. According to Duffie (1996) the more liquid of otherwise identical bonds should trade on special. Table VI shows that controlling for demand and supply effects and the quality of collateral, the more liquid bond does indeed trade more on special regardless of the repo term. Specifically our measures of liquidity Quotes is always of the correct sign and is significant in three out of four instances the only exception being the ON1 repo. Consistent with this liquidity influence, we find that specialness is positively associated with a larger number of trades in a given repo. This implies that repo transactions tend to be concentrated in certain bonds possibly because they are the more liquid of potential candidates eligible to execute a given trading strategy. Specifically we find that the Trades variable is always positive and is statistically significant in three of four instances, the exception being the coefficient on the S1W repo term.

Finally we examine counterparty credit risk, a factor so far neglected in the repo literature. As we noted earlier Italian repos are exclusively "buy sellbacks" and so offer less protection and higher counterparty credit risk than "classic" repos. We expect that as the modified duration of a bond trading on special increases the quality of collateral decreases leading to higher counterparty credit risk and less specialness. We find strong support for this hypothesis for our measure of the quality of collateral, Quality, is of the correct sign and significant for the ON1, SN and S1W repo terms. The sole exception is for the TN term where the coefficient is of the correct sign but statistically insignificant.

To check for robustness, we split our sample into two roughly equal sub samples.[11] We follow the same econometric steps in regard to possible high collinearity, autocorrelation and heteroscedasticity as in the full sample. The second and third panels of Table V show the results of the F and Hausman (1978) specification tests that as discussed previously determines whether the constant is unique for each bond in the sample and whether a fixed or random effects estimator is appropriate respectively. We reach the same conclusions as previously, namely we should correct for first order autocorrelation and a fixed effects dummy variable regression is the appropriate econometric specification for our model. Moreover the F test is confirming that within the two sub-periods, as well as for the overall period, there are factors unique to a given bond beyond general supply and demand, liquidity and credit risk influences, that determine its' specialness.

We find that our full sample results hold true in the sub-period results. Specifically when a coefficient is significant in the sub-period regressions, it is of the correct sign. We conclude that our model is robust as the coefficients are stable with respect to sub-period regressions.

## V Summary and Conclusions

Our model examines the factors that are supposed to determine the degree of specialness for special collateral repos. We conclude that supply and demand effects are important influences of the degree of specialness for all repo terms in the Italian repo market thereby finding strong support for Duffie (1996). Like Duffie (1996) we

[11] It is difficult to split the sample into equal calendar sub-periods in any meaningful way, as the data is unbalanced panel data in that for some periods there are many more cross sectional observations than in other periods. Moreover the unbalanced nature of the data varies by repo term Therefore to split the sample into roughly equal sizes we divide the sample by two and then adjust the resulting cut off to ensure the first sub-period ends at the last observation for the date thereby selected.

find that all else equal, more liquid bonds trade more on special and like Moulton (2004) market conditions such as interest rate volatility increases the degree of specialness in the Italian repo market. In addition our results show that credit risk should be added to liquidity and supply and demand effects as an important factor for explaining the degree of specialness in the repo bond market. Moreover an increase in the bid ask spread in the bond market for bonds that trade on special in the repo market is associated with increasing information uncertainty and speculative demand and ultimately with an increase in specialness for shorter term repos. We also find that some bonds are more on special than others for factors that are unique to a given bond possibly because some traders believe these bonds are uniquely suited to their trading strategy.

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**Table I**

This table reports summary statistics of the cash volumes of trades on the MTS repo market for the two-year period April 1, 2003 to March 31, 2005.

| **Cash Volumes** | **General Collateral** (€ Millions) | **Special Collateral** (€ Millions) | **Total** (€ Millions) |
|---|---|---|---|
| Daily Average | 29,255 | 23,561 | 52,816 |
| Standard Deviation | 340 | 187 | 352 |
| Minimum | 3,835 | 9,136 | 14,251 |
| Maximum | 48,643 | 35,042 | 74,470 |
| Trading Days | 511 | 511 | 511 |
| **Total** | 14,949,135 | 12,039,766 | 26,988,900 |

**Table II**

This table reports summary statistics of tomorrow next TN repo rates on the MTS repo market for the two-year period April 1, 2003 to March 31, 2005. Statistical parameter data are in percent.

| **Repo rates** | **General Collateral** | **Special Collateral** | **Difference** |
|---|---|---|---|
| Mean | 2.09 | 2.00 | 0.09 |
| Median | 2.06 | 2.01 | 0.05 |
| Mode | 2.05 | 2.00 | 0.05 |
| Standard Deviation | 0.14 | 0.24 | -0.10 |
| Kurtosis | 7.53 | 210.56 | -203.03 |
| Skewness | 2.57 | -7.17 | 9.74 |
| Minimum | 1.59 | -8.04 | 9.63 |
| Maximum | 2.79 | 3.11 | -0.32 |
| Observations | 717 | 36,239 | -35,522 |

*Panel Tomorrow Next Repo Rate Distribution*

| Repo Rate (in percent) | Number of Observations | | |
|---|---|---|---|
| | General Collateral | Special Collateral | Difference |
| -1.00 | 0 | 9 | -9 |
| -0.75 | 0 | 3 | -3 |
| -0.50 | 0 | 4 | -4 |
| -0.25 | 0 | 8 | -8 |
| 0.00 | 0 | 30 | -30 |
| 0.25 | 0 | 14 | -14 |
| 0.50 | 0 | 44 | -44 |
| 0.75 | 0 | 43 | -43 |
| 1.00 | 0 | 88 | -88 |
| 1.25 | 0 | 129 | -129 |
| 1.50 | 0 | 441 | -441 |
| 1.75 | 3 | 1125 | -1122 |
| 2.00 | 42 | 15312 | -15270 |
| 2.25 | 616 | 16093 | -15477 |
| 2.50 | 8 | 1846 | -1838 |
| 2.75 | 47 | 1049 | -1002 |
| 3.00 | 1 | 0 | 1 |
| 3.25 | 0 | 1 | -1 |
| Total | 717 | 36239 | -35522 |

**Table III**

This table reports the details of the distribution of specialness of repo rates on Italian BTP bonds for the two-year period from April 1, 2003 to March 31, 2005. Specialness is measured in basis points as the difference between the daily average Italian general collateral rate and the daily average special rate on a given Italian BTP bond. Panel A presents summary statistics where statistical parameters are reported in basis points and Panel B reports the frequency distribution of the degree of specialness.

*Panel A: Summary Statistics*

| Repo Term | ON1 | TN | SN | S1W |
|---|---|---|---|---|
| **Bonds** | 52 | 67 | 67 | 65 |
| **Observations** | 3,050 | 17,535 | 23,141 | 2,045 |
| **Mean** | 17.392 | 7.653 | 4.335 | 4.338 |
| **Median** | 12.976 | 5.000 | 2.443 | 3.500 |
| **Mode** | 9.000 | 1.868 | 1.717 | 4.000 |
| **Standard Deviation** | 23.605 | 17.316 | 12.797 | 5.850 |
| **Kurtosis** | 51.471 | 1070.466 | 1574.800 | 94.706 |
| **Skewness** | 6.302 | 24.401 | 28.312 | 7.588 |
| **Range** | 336.063 | 1026.873 | 978.654 | 106.333 |
| **Minimum** | -5.111 | -9.771 | -7.941 | -5.000 |
| **Maximum** | 330.952 | 1017.102 | 970.712 | 101.333 |

*Panel B: Degree of Specialness*

| **Degree of Specialness (basis points)** | ***ON1*** | | ***TN*** | | SN | | S1W | |
|---|---|---|---|---|---|---|---|---|
| | # | % | # | % | # | % | # | % |
| -7.5 | 0 | 0.00 | 2 | 0.01 | 1 | 0.00 | 0 | 0.00 |
| -5.0 | 1 | 0.03 | 10 | 0.06 | 8 | 0.03 | 1 | 0.05 |
| -2.5 | 3 | 0.10 | 11 | 0.06 | 33 | 0.14 | 20 | 0.98 |
| 0.0 | 12 | 0.39 | 114 | 0.65 | 409 | 1.77 | 163 | 7.97 |
| 2.5 | 53 | 1.74 | 2384 | 13.60 | 11387 | 49.21 | 549 | 26.85 |
| 5.0 | 187 | 6.13 | 6248 | 35.63 | 6914 | 29.88 | 771 | 37.70 |
| 7.5 | 359 | 11.77 | 4233 | 24.14 | 2171 | 9.38 | 276 | 13.50 |
| 10.0 | 460 | 15.08 | 1859 | 10.60 | 917 | 3.96 | 141 | 6.89 |
| 12.5 | 387 | 12.69 | 899 | 5.13 | 414 | 1.79 | 50 | 2.44 |
| 15.0 | 426 | 13.97 | 522 | 2.98 | 208 | 0.90 | 24 | 1.17 |
| 17.5 | 359 | 11.77 | 314 | 1.79 | 154 | 0.67 | 11 | 0.54 |
| 20.0 | 217 | 7.11 | 189 | 1.08 | 78 | 0.34 | 13 | 0.64 |
| 22.5 | 150 | 4.92 | 129 | 0.74 | 63 | 0.27 | 3 | 0.15 |
| 25.0 | 79 | 2.59 | 94 | 0.54 | 38 | 0.16 | 4 | 0.20 |
| 27.5 | 67 | 2.20 | 82 | 0.47 | 25 | 0.11 | 4 | 0.20 |
| 30.0 | 58 | 1.90 | 63 | 0.36 | 30 | 0.13 | 1 | 0.05 |
| 32.5 | 32 | 1.05 | 35 | 0.20 | 24 | 0.10 | 2 | 0.10 |
| 35.0 | 24 | 0.79 | 33 | 0.19 | 30 | 0.13 | 2 | 0.10 |
| 37.5 | 12 | 0.39 | 23 | 0.13 | 26 | 0.11 | 2 | 0.10 |
| 40.0 | 12 | 0.39 | 24 | 0.14 | 20 | 0.09 | 0 | 0.00 |
| 42.5 | 7 | 0.23 | 27 | 0.15 | 15 | 0.06 | 0 | 0.00 |
| 45.0 | 12 | 0.39 | 19 | 0.11 | 13 | 0.06 | 0 | 0.00 |
| 47.5 | 5 | 0.16 | 15 | 0.09 | 13 | 0.06 | 0 | 0.00 |
| 50.0 | 11 | 0.36 | 13 | 0.07 | 9 | 0.04 | 0 | 0.00 |
| More than 50 | 117 | 3.84 | 193 | 1.10 | 141 | 0.61 | 8 | 0.39 |
| Total | 3050 | 100.00 | 17535 | 100.00 | 23141 | 100.00 | 2045 | 100.00 |

**Table IV**

This table reports the correlation matrix amongst the eight independent variables in our model used to explain repo specialness of Italian BTP bonds for the two-year period ending March 31, 2005. Supply is the total cash volume of bonds available for sale at the top three levels of the ask price, Trade Imbalance is the aggregate buy initiated volume minus aggregate sell initiated volume, volatility is the implied one year Italian interest rate volatility, quantity is the daily amount of a bond on special that is repoed, quality is the bond's modified duration, trades are the number of trades that occurred in the repo market for a bond on special, quotes are the number of quote updates in the cash market for a bond on special and Spread is the daily time weighted average percentage bid ask spread for a bond on special.

| | Supply | Trade Imbalance | Vol | Quantity | Quality | Trades | Quotes | Spread |
|---|---|---|---|---|---|---|---|---|
| ON1 | | | | | | | | |
| Supply | 1.00 | 0.42 | -0.11 | 0.13 | -0.30 | 0.11 | -0.17 | -0.51 |
| Trade Imbalance | 0.42 | 1.00 | 0.01 | 0.13 | -0.22 | 0.08 | 0.06 | -0.22 |
| Vol | -0.11 | 0.01 | 1.00 | -0.10 | 0.03 | -0.10 | 0.26 | 0.04 |
| Quantity | 0.13 | 0.13 | -0.10 | 1.00 | 0.00 | 0.63 | 0.05 | 0.01 |
| Quality | -0.30 | -0.22 | 0.03 | 0.00 | 1.00 | -0.05 | 0.15 | 0.19 |
| Trades | 0.11 | 0.08 | -0.10 | **0.63** | -0.05 | 1.00 | 0.02 | 0.05 |
| Quotes | -0.17 | 0.06 | 0.26 | 0.05 | 0.15 | 0.02 | 1.00 | 0.36 |
| Spread | -0.51 | -0.22 | 0.04 | 0.01 | 0.19 | 0.05 | 0.36 | 1.00 |
| TN | | | | | | | | |
| Supply | 1.00 | 0.09 | -0.31 | 0.19 | -0.21 | 0.18 | -0.19 | -0.36 |
| Trade Imbalance | 0.09 | 1.00 | -0.05 | 0.04 | 0.06 | 0.04 | -0.02 | 0.02 |
| Vol | -0.31 | -0.05 | 1.00 | -0.13 | -0.04 | -0.04 | 0.38 | 0.13 |
| Quantity | 0.19 | 0.04 | -0.13 | 1.00 | 0.15 | 0.73 | -0.01 | 0.03 |
| Quality | -0.21 | 0.06 | -0.04 | 0.15 | 1.00 | 0.16 | 0.26 | 0.84 |
| Trades | 0.18 | 0.04 | -0.04 | **0.73** | 0.16 | 1.00 | 0.04 | 0.06 |
| Quotes | -0.19 | -0.02 | 0.38 | -0.01 | 0.26 | 0.04 | 1.00 | 0.34 |
| Spread | -0.36 | 0.02 | 0.13 | 0.03 | **0.84** | 0.06 | 0.34 | 1.00 |
| SN | | | | | | | | |
| Supply | 1.00 | 0.09 | -0.31 | 0.47 | -0.15 | 0.50 | -0.17 | -0.30 |
| Trade Imbalance | 0.09 | 1.00 | -0.05 | 0.08 | 0.06 | 0.09 | -0.02 | 0.03 |
| Vol | -0.31 | -0.05 | 1.00 | -0.20 | -0.05 | -0.15 | 0.36 | 0.12 |
| Quantity | 0.47 | 0.08 | -0.20 | 1.00 | 0.30 | 0.85 | 0.04 | 0.09 |
| Quality | -0.15 | 0.06 | -0.05 | 0.30 | 1.00 | 0.31 | 0.27 | 0.84 |
| Trades | 0.50 | 0.09 | -0.15 | **0.85** | 0.31 | 1.00 | 0.08 | 0.11 |
| Quotes | -0.17 | -0.02 | 0.36 | 0.04 | 0.27 | 0.08 | 1.00 | 0.35 |
| Spread | -0.30 | 0.03 | 0.12 | 0.09 | **0.84** | 0.11 | 0.35 | 1.00 |
| S1W | | | | | | | | |
| Supply | 1.00 | 0.36 | -0.37 | 0.08 | -0.25 | 0.06 | -0.25 | -0.06 |
| Trade Imbalance | 0.36 | 1.00 | 0.00 | 0.19 | -0.05 | 0.07 | 0.11 | -0.01 |
| Vol | -0.37 | 0.00 | 1.00 | 0.03 | -0.05 | 0.00 | 0.46 | 0.05 |
| Quantity | 0.08 | 0.19 | 0.03 | 1.00 | 0.06 | 0.60 | 0.09 | 0.06 |
| Quality | -0.25 | -0.05 | -0.05 | 0.06 | 1.00 | 0.06 | 0.27 | 0.13 |
| Trades | 0.06 | 0.07 | 0.00 | **0.60** | 0.06 | 1.00 | 0.05 | 0.01 |
| Quotes | -0.25 | 0.11 | 0.46 | 0.09 | 0.27 | 0.05 | 1.00 | 0.11 |
| Spread | -0.06 | -0.01 | 0.05 | 0.06 | 0.13 | 0.01 | 0.11 | 1.00 |

**Table V**

This table reports the results of two specification tests. The first tests whether the panel data should contain a unique dummy for each bond in the sample where rejection of the null suggests it should. The test statistic is distributed $\chi^2$ with a number of degrees of freedom equal to the number of non-zero dummies. The second is the Hausman (1978) test that determines whether the panel data should include a fixed or a random effects estimator. Rejection of the null suggests a random effects specification is appropriate. The Hausman (1978) test statistic is distributed $\chi^2$ with a number of degrees of freedom equal to the number of slope coefficients including lagged terms necessary for first order autocorrelation adjustment. For all test statistics we reject the null for large values.

| *Full Sample Period April 1, 2003 to March 31, 2005* | | | | |
|---|---|---|---|---|
| | ON1 | TN | SN | S1W |
| $\chi^2$ test for individual effects | | | | |
| $\chi^2$ (degrees of freedom) | 215.01 | 889.89 | 962.11 | 1517.83 |
| | (51) | (66) | (66) | (64) |
| Significance | 0.00% | 0.00% | 0.00% | 0.00% |
| Hausman Test for random effects | | | | |
| $\chi^2$ (degrees of freedom) | 5.73 (17) | 5.61 (17) | 5.35 (17) | 4.42 (17) |
| Significance | 99.48% | 99.54% | 99.66% | 99.90% |
| *First half of full sample* | | | | |
| | ON1 | TN | SN | S1W |
| $\chi^2$ test for individual effects | | | | |
| $\chi^2$ (degrees of freedom) | 180.81 | 549.58 | 531.64 | 806.14 |
| | (49) | (60) | (60) | (56) |
| Significance | 0.00% | 0.00% | 0.00% | 0.00% |
| Hausman Test for random effects | | | | |
| $\chi^2$ (degrees of freedom) | 5.49 (17) | 2.62 (17) | 2.70 (17) | 2.46 (17) |
| Significance | 99.60% | 99.99% | 99.95% | 99.98% |
| *Second half of full sample* | | | | |
| | ON1 | TN | SN | S1W |
| $\chi$ 2 test for individual effects | | | | |
| $\chi^2$ (degrees of freedom) | 427.47 | 603.97 | 717.42 | 720.06 |
| | (46) | (53) | (53) | (52) |
| Significance | 0.00% | 0.00% | 0.00% | 0.00% |
| Hausman Test for random effects | | | | |
| $\chi^2$ (degrees of freedom) | 5.33 (17) | 4.53 (17) | 5.84 (17) | 2.94 (17) |
| Significance | 99.67% | 99.88% | 99.42% | 99.99% |

**Table VI**

This table reports the dummy variable fixed effects estimate of our model for the full 24-month sample period and for two sub-periods. Supply is the total cash volume of bonds available for sale at the top three levels of the ask price, Trade Imbal is the aggregate buy initiated volume minus aggregate sell initiated volume, volatility is the implied one year Italian interest rate volatility, quantity is the daily amount of a bond on special that is repoed, quality is the bond's modified duration, trades are the number of trades that occurred in the repo market for a bond on special, quotes are the number of quote updates in the cash market for a bond on special and Spread is the daily time weighted average percentage bid ask spread for a bond on special. The panel regression is also corrected for first order autocorrelation and heteroscedasticity using Newey and West (1987).

| | ON1 | | TN | | SN | | S1W | |
|---|---|---|---|---|---|---|---|---|
| *Full Period: April 1, 2003 to March 31, 2005* | | | | | | | | |
| Variable | Coeff. | t-stat. | Coeff. | t-stat. | Coeff. | t-stat. | Coeff. | t-stat. |
| Supply | -0.032 | -1.173 | -0.021*** | -4.723 | -0.022*** | -5.589 | -0.013*** | -2.690 |
| Trade Imbal | 0.018*** | 4.051 | 0.008* | 1.956 | 0.002 | 0.797 | 0.002 | 0.955 |
| Vol | 0.604*** | 3.688 | 0.103 | 1.639 | 0.063 | 1.407 | 0.205*** | 3.942 |
| Quantity | -0.020** | -2.120 | -0.019*** | -5.333 | -0.010*** | -6.346 | -0.011*** | -2.685 |
| Quality | -1.947*** | -3.169 | -0.596 | -0.792 | -1.334*** | -2.577 | -0.932** | -2.045 |
| Trades | 1.443*** | 4.089 | 1.597*** | 8.416 | 0.525*** | 12.250 | 0.214 | 1.153 |
| Quotes | 70.738 | 0.784 | 20.858** | 2.044 | 15.179** | 2.263 | 8.184*** | 3.613 |
| Spread | 8.885*** | 2.966 | 1.587*** | 3.169 | 1.329*** | 3.674 | -0.003* | -1.677 |
| DF | 2,817 | | 17,186 | | 22,646 | | 1,855 | |
| Adj. $R^2$ | 36.77% | | 19.68% | | 19.37% | | 25.02% | |
| *First Half of Sample* | | | | | | | | |
| Variable | Coeff. | t-stat. | Coeff. | t-stat. | Coeff. | t-stat. | Coeff. | t-stat. |
| Supply | 0.033 | 0.903 | -0.041*** | -5.040 | -0.043*** | -6.189 | -0.022** | -2.404 |
| Trade Imbal | 0.016** | 2.501 | 0.011** | 2.129 | 0.004 | 1.420 | 0.004 | 1.470 |
| Vol | 0.297 | 0.906 | -0.251 | -1.436 | -0.167 | -1.485 | -0.030 | -0.312 |
| Quantity | -0.041*** | -2.689 | -0.004 | -0.704 | -0.009*** | -3.044 | -0.013** | -2.327 |
| Quality | -4.226*** | -4.023 | -0.318 | -0.184 | -0.802 | -0.624 | 0.275 | 0.376 |
| Trades | 2.102*** | 3.207 | 1.684*** | 4.748 | 0.600*** | 9.157 | 0.225 | 1.145 |
| Quotes | 323.625** | 2.064 | 24.084* | 1.855 | 15.029* | 1.688 | 5.837** | 2.313 |
| Spread | 6.611** | 2.170 | 0.385 | 0.462 | 1.153*** | 2.582 | -0.004*** | -2.763 |
| DF | 1,321 | | 8,440 | | 11,115 | | 840 | |
| Adj. $R^2$ | 15.81% | | 16.28% | | 17.61% | | 38.79% | |
| *Second Half of Sample* | | | | | | | | |
| Variable | Coeff. | t-stat. | Coeff. | t-stat. | Coeff. | t-stat. | Coeff. | t-stat. |
| Supply | -0.128*** | -3.406 | -0.009 | -1.391 | -0.014*** | -2.585 | -0.005 | -0.406 |
| Trade Imbal. | 0.022*** | 3.005 | 0.002 | 0.399 | -0.002 | -0.497 | 0.001 | 0.007 |
| Vol | 0.840*** | 2.888 | 0.225*** | 3.712 | 0.237*** | 5.766 | 0.343*** | 3.442 |
| Quantity | -0.007 | -0.528 | -0.023*** | -5.796 | -0.012*** | -6.386 | -0.009 | -1.499 |
| Quality | -0.060 | -0.060 | -2.470*** | -4.142 | -3.888*** | -9.200 | -2.583** | -2.107 |
| Trades | 0.887** | 2.032 | 1.513*** | 9.628 | 0.532*** | 7.875 | 0.089 | 0.299 |
| Quotes | -80.614 | -0.676 | 56.583** | 2.418 | 23.444 | 1.496 | 151.942** | 2.376 |
| Spread | 11.854** | 2.222 | 1.663*** | 2.836 | 0.0530 | 0.144 | -0.006 | -0.196 |
| DF | 1,429 | | 8,690 | | 11,475 | | 954 | |
| Adj. $R^2$ | 45.98% | | 32.18% | | 29.88% | | 21.69% | |

*** Significant at the 1% level, ** Significant at the 5% level, * Significant at the 10% level.

Figure 1

This figure reports the time variation in repo specialness of the 5.25% BTP bond maturing on the first of August 2017 and the 4.25% BTP bond maturing on the first of August 2013. Repo specialness is measured as the difference between the Tomorrow Next general collateral rate and the respective special collateral rate of the candidate bond for the two-year period of our sample data from the first of April 2003 to the thirty first of March 2005.